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# RESEARCH MEMORANDUM

## WIND-TUNNEL INVESTIGATION AT HIGH SUBSONIC SPEEDS OF JET, SPOILER, AND AILERON CONTROLS ON A 1/16-SCALE MODEL OF THE DOUGLAS D-558-II RESEARCH AIRPLANE

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS
WASHINGTON
July 27, 1956



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56AA 46389

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

RESEARCH MEMORANDUM

# WIND-TUNNEL INVESTIGATION AT HIGH SUBSONIC SPEEDS OF JET, SPOILER, AND AILERON CONTROLS ON A 1/16-SCALE MODEL OF THE DOUGLAS D-558-II RESEARCH AIRPLANE

By Raymond D. Vogler

## SUMMARY

An investigation was made in the Langley high-speed 7- by 10-foot tunnel through a Mach number range from 0.60 to 0.96 to determine the characteristics of a wing trailing-edge jet control on a 1/16-scale model of the Douglas D-558-II research airplane. The control was operated with ram air obtained from wing-tip inlets. The characteristics of ailerons and trailing-edge spoilers were also obtained for comparison with the jet control.

The results indicated that at small angles of attack and at a Mach number of 0.60 the jet control was 85 percent as effective as the fully deflected ailerons, but at a Mach number of 0.96 the jet control was 25 percent more effective than the ailerons. This change in relative effectiveness is attributed to the fact that the jet control gave constant effectiveness through the Mach number range while the aileron effectiveness decreased rapidly between Mach numbers of 0.90 and 0.96. The spoilers, which projected 0.052 of the wing chord, were slightly more effective than either the ailerons or jets but showed about the same variation with Mach number as the ailerons. All three controls decreased in effectiveness at the higher angles of attack; however, all showed considerable effectiveness through the angle-of-attack range investigated. Some of the decrease in effectiveness of the jet control at high angles of attack can be attributed to the loss in the ratio of the pressure in the wing plenum chamber to the tunnel stagnation pressure. Increasing the diameter of the holes in the jet controls or increasing the control span gave more control effectiveness as long as the total jet-exit area did not greatly exceed the inlet area. The drag of the jet control was much greater than that of either the ailerons or spoilers. Most of this drag results from the installation of the jet-control system and not from its operation.



56AA 46389

## INTRODUCTION

The growing need for simplified airplane controls operating with smaller actuating forces than are now required has aroused considerable interest in the possibility of using air jets as controls. Some previous investigations of jet controls are reported in references 1 to 4.

The purpose of this investigation was to determine, primarily, the rolling-moment characteristics at high subsonic speeds of trailing-edge jet controls on a 1/16-scale model of the D-558-II research airplane, and to obtain a comparison of the effectiveness of the jet controls with the more conventional solid spoilers and ailerons. Jet controls with hole diameters from 0.063 inch to 0.172 inch were supplied ram air by means of a constant-diameter inlet in a wing-tip nacelle on each wing. Control span and location were also investigated. Force and moment data were obtained through a Mach number range of 0.6 to 0.96 and an angle-of-attack range of $-6^{\circ}$ to $21^{\circ}$ in the Langley high-speed 7- by 10-foot tunnel. In addition, some drag data were obtained with the inlet closed with a faired plug and with the inlet removed so that only the plenum chamber with the thickened trailing edge was attached to the wing.

## COEFFICIENTS AND SYMBOLS

The system of axes used and the positive directions of forces and moments used in the reduction of data are shown in figure 1. The origin of the system of axes was on the fuselage center line at a longitudinal position corresponding to the projection of the quarter-chord point of the mean aerodynamic chord onto the fuselage center line. The lift and drag coefficients are determined about the wind axes, and the rolling-, yawing-, and pitching-moment coefficients are determined about the body axes.

$C_L$ lift coefficient, $\frac{\text{Lift}}{qS}$

$C_D$ drag coefficient, $\frac{\text{Drag}}{qS}$

$C_m$ pitching-moment coefficient, $\frac{\text{Pitching moment}}{qS\bar{c}}$

$C_l$ rolling-moment coefficient, $\frac{\text{Rolling moment}}{qSb}$

$C_n$ yawing-moment coefficient, $\frac{\text{Yawing moment}}{qSb}$

$C_Y$ side-force coefficient, $\frac{\text{Side force}}{qS}$

$\Delta C_l$ net rolling-moment coefficient produced by the control

$\Delta C_n$ net yawing-moment coefficient produced by the control

$q$ dynamic pressure, $\frac{\rho V^2}{2}$, lb/sq ft

$\rho$ mass density of air, slugs/cu ft

$V$ free-stream air velocity, ft/sec

$S$ wing area (original model), sq ft

$b$ wing span (original model), ft

$c$ local wing chord, ft

$\bar{c}$ mean aerodynamic chord of wing, ft

$M$ Mach number

$\alpha$ angle of attack of fuselage, deg

$p$ total pressure in wing plenum chamber

$p_t$ tunnel stagnation pressure, lb/sq ft

$w$ weight flow of air, lb/sec

$D$ jet diameter, in.

Subscript:

$w$ indicates wind axes (see fig. 1)

## MODEL AND APPARATUS

The plain-wing model used in this investigation was a 1/16-scale aluminum model of the Douglas D-558-II research airplane with two minor

differences. These modifications were an enlarged section at the rear of the model fuselage to allow attachment of a sting support and a model thickness ratio at the wing tip of 10 percent instead of 12 percent. A three-view drawing of the model equipped with wing-tip inlets and jet controls is shown in figure 2 and a photograph in figure 3.

Details of the various controls investigated are given in figures 4 and 5. Controls were on both wing panels for each configuration. The jet-control configuration (fig. 4) consisted of a box-like plenum chamber replacing part of the trailing edge of the wing and a wing-tip nacelle having a 7/8-inch-diameter cylindrical inlet. The jet control with the smaller plenum chamber (fig. 4(a)) had 39 jet holes and was investigated with hole diameters of 0.0625 inch, 0.081 inch, and 0.099 inch. The control with the larger plenum chamber (fig. 4(b)) had only 24 holes and was investigated with hole diameters of 0.125 inch, 0.140 inch, 0.156 inch, and 0.172 inch. Part of the wing structure at the entrance to the plenum chambers of both configurations was faired to provide better flow in the throat, and in the larger chamber a turning vane was also used. Studs were used to reduce the flexibility of the walls of the larger chamber. Provision for obtaining aileron deflection by bending was made by cutting a spanwise groove along the 0.85-chord line of the original model without the tip nacelle (fig. 5). The trailing-edge spoiler was made of 0.016-inch-thick steel (fig. 5) and projected 0.052c. Figure 6 shows some modifications to the configuration used in assessing the drag increase.

The model was mounted on a sting-type support system in the Langley high-speed 7- by 10-foot tunnel. The sting was supported by a vertical strut downstream from the test section. The support system allowed the angle of attack of the model to be varied by rotating the model and sting in the vertical plane about an axis through the quarter-chord point of the wing mean aerodynamic chord. The forces and moments were measured by means of an electrical strain-gage balance mounted inside the fuselage. The forces and moments and the total pressure inside the plenum chamber were recorded on calibrated potentiometers.

## TESTS

Data were obtained in the Langley high-speed 7- by 10-foot tunnel at Mach numbers of 0.60, 0.80, 0.85, 0.90, and 0.96 and at angles of attack generally from $-6^{\circ}$ to $21^{\circ}$ except at the highest Mach number where the range was less. Tests were made of the original model with no controls, with trailing-edge spoilers, and with ailerons deflected equally and oppositely $7.5^{\circ}$ and $15^{\circ}$. The plan form of the model was then changed by adding a wing-tip inlet and replacing part of the wing with a small plenum chamber with 39 jet holes in it at the trailing edge. Data for

this configuration were obtained with the holes closed and with open holes of three diameters - 0.0625 inch, 0.081 inch, and 0.099 inch. Some tests were also made of this configuration with the inlet closed with a round nose plug, and with the inlet removed but with the plenum chamber with jets closed attached to the wing. A larger plenum chamber with 24 jet holes and a wing-tip inlet of the same diameter as that used with the smaller plenum chamber but with a longer tail cone was installed. Tests of this configuration were made with the jet holes closed and with all holes open with jet-hole diameters of 0.125 inch, 0.140 inch, 0.156 inch, and 0.172 inch. In addition, data were obtained with the 0.125-inch jet holes with only 6, 12, and 18 inboard jets open, and data were obtained with the 0.172-inch jets with only 12 and with 18 outboard jets open.

The test Reynolds number (based on the mean aerodynamic chord) varied from about $1.45 \times 10^6$ at a Mach number of 0.6 to about $1.75 \times 10^6$ at a Mach number of 0.96.

## CORRECTIONS

Blocking corrections as determined by the method of reference 5 have been applied to Mach number and dynamic pressure. Jet-boundary corrections were calculated by the method of reference 6 and were applied to the angle of attack and drag. The drag coefficients have also been adjusted to correspond to coefficients where the pressure at the base of the fuselage is equal to free-stream static pressure.

## RESULTS AND DISCUSSION

The force and moment coefficients obtained in the investigation are presented in tabular form in tables I to III except for some drag-coefficient results of the effects of various modifications to the jet configuration which are presented in graphic form. There were three basic model configurations as indicated in the three tables of data: (a) the original model using aileron and spoiler controls, (b) the model with the small plenum chamber and jet controls, (c) the model with the large plenum chamber and jet controls. Each basic configuration had its own no-controls-operating data. The rolling-moment coefficients for the no-controls-operating conditions are not zero and are not the same for all three configurations as a result of model asymmetry and wing modifications.

## Lateral-Control Characteristics of Jet Controls

The rolling-moment coefficients $C_l$ of the jet control with small plenum chamber are fairly constant at low angles of attack, are erratic at angles of attack between $6^{\circ}$ and $12^{\circ}$, and are considerably reduced at the higher angles of attack as shown in figure 7. This erratic rolling behavior seems to be associated with a wing-dropping phenomenon inherent in the plain-wing model. Increasing the diameter of the jet holes increased the rolling-moment coefficients (fig. 7). The yawing-moment coefficients $C_n$ were small and generally favorable.

The results obtained with larger jet holes in a larger plenum chamber are given in figure 8. The rolling-moment variation with angle of attack is similar to that obtained with the smaller jet holes of the previously discussed configuration, but there is a considerable increase in the magnitude of the rolling-moment coefficients. The yawing moments were generally favorable except at high angles of attack.

There is an increase in rolling-moment coefficient with increase in jet-hole diameter for the large plenum-chamber jet-control configuration as was the case for the smaller plenum-chamber configuration. However, as the ratio of the total exit area of the jet holes to the inlet area into the plenum chamber approaches 1.0 there is only a small increase in rolling-moment coefficient with increase in jet-hole diameter. For example, there is little increase in rolling-moment coefficient with increase in jet-hole diameter between 0.156 to 0.172 (fig. 8) for which the ratios of total exit area to inlet area are approximately 0.90 and 1.10, respectively. With an inlet designed for supersonic speeds there might be an advantage in having jet holes large enough to have a ratio of exit area to inlet area greater than 1.0.

Shorter-span controls starting inboard with 0.125-inch jets and starting at the wing tip with 0.172-inch jets were investigated on the large plenum-chamber jet-control configuration and the results are presented in figure 9. These shorter-span controls were made by sealing 6 jet holes and multiples of 6 holes without other changes to the configuration. The data indicate that, as was found for trailing-edge ailerons over this spanwise location, the rolling-moment coefficients are generally proportional to the span of the control for controls starting either at the tips or the inboard end of the controls.

## Comparison of Jet Controls with Ailerons and Spoilers

A comparison of the effectiveness of the jet control with the ailerons of the original model and with trailing-edge spoilers projected 0.052c is given in figure 10. The rolling and yawing moments of the ailerons were opposite in sign to the moments of the spoiler and jet

controls but have been plotted with the same sign for easier visual comparison. The erratic rolling behavior of the model at moderate (between $5^\circ$ and $12^\circ$) angles of attack with all three controls is evident. At small angles of attack the jet control is about 85 percent as effective as the ailerons fully deflected ($\pm15^\circ$) at a Mach number of 0.60 but becomes more nearly equal as the Mach number increases, and at a Mach number of 0.96 the jet control is about 25 percent more effective than the ailerons. The trailing-edge spoiler is more effective than either the jet or the ailerons at small angles of attack. At angles of attack between $5^\circ$ and $12^\circ$ the effectiveness of all three controls decreases, with the jet-control effectiveness decreasing at a faster rate and becoming less effective than either the ailerons or spoilers at high angles of attack. At angles of attack near zero lift ($\alpha = -2$), the jet control has almost constant effectiveness through the Mach number range while both the aileron and spoiler controls show a decrease in effectiveness at $M = 0.96$ (fig. 11). However, all controls retain considerable effectiveness throughout the angle-of-attack and Mach number range investigated. The yawing moments of all controls are favorable in the low angle-of-attack range but become less favorable as the angle of attack increases above $8^\circ$ or $10^\circ$. (See fig. 10.)

## Pressures and Weight Flow

Pressures in the large plenum chamber were obtained for all jet-hole diameters and spans investigated. The variation of the ratio of plenum-chamber pressure to tunnel-stagnation pressure with angle of attack is given in figure 12 for the various jet controls. No pressures were obtained for the small plenum-chamber configuration. The pressure ratios of figure 12 show a decrease as the jet diameter or control span increases, as would be expected. There is also a decrease in pressure ratio with increase in angle of attack. This decrease in pressure ratio with angle of attack accounts for some of the decrease in effectiveness of the jet control with angle of attack. Some of the pressure loss in the plenum chamber at high angles of attack might be regained with a better designed inlet thereby increasing the rolling moments by providing a larger quantity of air for the jets.

A knowledge of the actual weight of air used by the jet control would be useful if the air necessary for control were obtained from some other source such as an auxiliary jet engine. Calculated values of weight flow will be only as accurate as the estimated orifice-flow coefficient of the jets. Flow coefficients are obtainable for jets operating under specified conditions but the effect on flow coefficients of the shape of the plenum chamber and the adjacency of the jet holes to each other is unknown. Consequently, the weight-flow values in figure 13 are based on the actual jet diameters without any flow-correction factor. It is roughly estimated that the correct values are 60 to 86 percent of

the values given in figure 13. However, comparisons of the effectiveness of controls of different span and jet diameters based on relative weight flows would probably be as valid as if the comparisons were based on the actual weight flows of air.

The data shown in figure 13 indicate that a control with smaller jet holes and a longer span is more effective per pound of air used than controls with larger jet holes and shorter spans. For instance, the 0.125-inch jets extending from 0.55 to 1.00 semispan and the 0.172-inch jets extending from 0.66 to 1.00 semispan produce approximately equal rolling-moment coefficients but the larger-diameter shorter-span control uses about 35 percent more air. This would be an important point to consider if the air for the controls were furnished by an auxiliary jet engine, but from a structural standpoint on some airplanes it might be better to use controls of shorter span and larger jets if ram air is used for operation.

## Drag

It was anticipated that the drag of the model with the jet control would be considerably higher than that of the model with the original ailerons since the jet system was designed primarily to produce roll rather than low drag in this investigation. The drag data are presented in figure 14 and show that not only is the drag greater but most of it is still present when the control is not operating. At low lift coefficients, the model with the nonoperating jet control has drag coefficients about 75 percent greater than the original model with ailerons undeflected (plain wing). Also the model with operating jet control has coefficients 50 to 65 percent greater than the model with ailerons fully deflected. A large part of the drag of the jet control probably could be eliminated if the wing-tip inlets were replaced by an internal duct system taking air from the engine. It is also believed that the drag could be considerably reduced with wing-tip inlets designed for low drag. For the nonoperating condition, the inlets might have exits designed to allow the air to pass directly through with minimum shocks and skin friction drag. A few tests were made to determine whether the excess drag of the jet control could be materially reduced. A faired nose plug in the inlet reduced the excess drag of the nonoperating jet control by 55 to 75 percent as shown in figure 15. In practice the plug might be replaced by an eyelid type of closing device. A considerable part of the excess drag is produced by the thickened trailing edge of the wing at the lower Mach numbers but the thickened trailing edge becomes less objectionable as the Mach number increases.

## CONCLUSIONS

A wind-tunnel investigation to determine the characteristics of a jet control operated by ram air and located at the wing trailing edge of a 1/16-scale model of the D-558-II research airplane resulted in the following conclusions:

1. At small angles of attack and at a Mach number of 0.60 the 45-percent-span outboard jet controls are 85 percent as effective as the original ailerons fully deflected, but at a Mach number of 0.96 the jet controls are 25 percent more effective than the ailerons. Trailing-edge spoilers of approximately the same span as the other controls and projecting 0.052 of the wing chord are more effective than the fully deflected ailerons or the jet controls at small angles of attack.

2. At angles of attack near zero lift the jet controls give almost constant control effectiveness through the Mach number range investigated, whereas the effectiveness of the spoilers and the ailerons decreases between Mach numbers 0.90 and 0.96.

3. All three controls decrease in effectiveness at moderate ($5^{\circ}$ to $12^{\circ}$) angles of attack with the jet control decreasing at a faster rate and becoming less effective than the spoilers or the ailerons at high angles of attack. Some of the decrease in effectiveness of the jet control can be attributed to the loss in pressure ratio in the wing at the higher angles of attack. However, all controls retain considerable effectiveness through the angle-of-attack range investigated.

4. Increasing the jet diameter or increasing the control span increases the rolling-moment coefficients as long as the total jet-exit area does not greatly exceed the inlet area.

5. The drag of the jet control greatly exceeds that of the aileron and was more than that of the spoiler; however, most of the drag results from the installation of the jet system and not from its operation.

Langley Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., May 9, 1956.

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TABLE I.- DATA OBTAINED WITH AILERONS AND SPOILERS

ON MODEL WITH ORIGINAL WINGS

| Plain wing | | | | | | | Trailing-edge spoilers projecting 0.052c. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_m$ | $C_l$ | $C_n$ | $C_Y$ | $\alpha$ | $C_L$ | $C_D$ | $C_m$ | $C_l$ | $C_n$ | $C_Y$ |
| M = 0.60 | | | | | | | M = 0.60 | | | | | | |
| -4.09 | -.1593 | .0218 | .0935 | -.0005 | .0001 | .0102 | -4.09 | -.1679 | .0405 | .1055 | -.0355 | -.0062 | .0146 |
| -1.97 | -.0028 | .0180 | .0568 | -.0004 | .0000 | .0091 | -1.96 | -.0049 | .0364 | .0660 | -.0356 | -.0061 | .0152 |
| 0.15 | .1568 | .0202 | .0237 | -.0003 | .0001 | .0086 | 0.16 | .1575 | .0369 | .0293 | -.0354 | -.0051 | .0144 |
| 2.28 | .3158 | .0279 | -.0048 | -.0007 | .0001 | .0067 | 2.28 | .3346 | .0436 | -.0091 | -.0339 | -.0042 | .0155 |
| 4.40 | .4747 | .0459 | -.0342 | -.0006 | -.0004 | .0046 | 4.43 | .5112 | .0641 | -.0456 | -.0324 | -.0039 | .0147 |
| 6.53 | .6347 | .0878 | -.0667 | -.0031 | -.0019 | .0097 | 6.57 | .7011 | .1068 | -.1001 | -.0285 | -.0028 | .0119 |
| 8.64 | .7244 | .1365 | -.0243 | -.0016 | -.0001 | .0125 | 8.68 | .8244 | .1612 | -.1145 | -.0266 | .0005 | .0061 |
| 10.68 | .7663 | .1834 | -.0445 | -.0016 | -.0004 | .0065 | 10.72 | .8530 | .2084 | -.0894 | -.0245 | .0019 | .0041 |
| 12.71 | .7837 | .2241 | -.0169 | -.0009 | -.0004 | .0064 | 12.76 | .8603 | .2497 | -.0613 | -.0207 | .0015 | .0020 |
| 14.72 | .7989 | .2625 | -.0279 | -.0006 | -.0006 | .0052 | 14.77 | .8746 | .2913 | -.0674 | -.0187 | .0015 | .0014 |
| 16.75 | .8306 | .3050 | -.0601 | -.0016 | .0000 | .0055 | 16.81 | .9082 | .3372 | -.0978 | -.0196 | .0024 | -.0019 |
| 18.81 | .8995 | .3644 | -.0896 | -.0026 | .0005 | .0027 | 18.84 | .9626 | .3931 | -.1255 | -.0210 | .0037 | -.0046 |
| 20.83 | .9397 | .4143 | -.1174 | -.0048 | .0029 | .0000 | 20.57 | .6771 | .3195 | -.1542 | -.0229 | .0045 | -.0114 |
| M = 0.80 | | | | | | | M = 0.80 | | | | | | |
| -4.13 | -.1718 | .0201 | .1080 | -.0007 | .0001 | .0040 | -4.13 | -.1823 | .0398 | .1214 | -.0343 | -.0053 | .0155 |
| -1.93 | .0079 | .0163 | .0678 | -.0007 | .0000 | .0048 | -1.92 | .0062 | .0352 | .0793 | -.0342 | -.0052 | .0162 |
| 0.27 | .1870 | .0196 | .0338 | -.0007 | -.0003 | .0036 | 0.28 | .1970 | .0373 | .0361 | -.0333 | -.0045 | .0155 |
| 2.49 | .3824 | .0322 | -.0027 | -.0007 | -.0002 | .0037 | 2.51 | .3921 | .0487 | -.0034 | -.0327 | -.0041 | .0153 |
| 4.71 | .5766 | .0652 | -.0411 | -.0010 | -.0006 | .0034 | 4.73 | .6117 | .0809 | -.0628 | -.0292 | -.0033 | .0140 |
| 6.84 | .6773 | .1092 | -.0543 | .0014 | .0004 | .0030 | 6.93 | .7762 | .1328 | -.0988 | -.0265 | -.0003 | .0090 |
| 8.91 | .7316 | .1540 | -.0479 | -.0092 | -.0014 | .0082 | 8.96 | .7854 | .1733 | -.0868 | -.0248 | .0006 | .0056 |
| 10.94 | .7267 | .1899 | -.0201 | -.0011 | -.0003 | .0039 | 11.01 | .8055 | .2142 | -.0665 | -.0211 | .0006 | .0059 |
| 13.00 | .7617 | .2343 | -.0295 | -.0018 | -.0003 | .0032 | 13.05 | .8372 | .2585 | -.0716 | -.0219 | .0009 | .0005 |
| 15.03 | .7943 | .2755 | -.0512 | -.0024 | .0001 | .0009 | 15.07 | .8580 | .2994 | -.0949 | -.0210 | .0011 | -.0022 |
| 17.10 | .8590 | .3284 | -.0797 | -.0034 | .0019 | -.0016 | 17.14 | .9083 | .3508 | -.1209 | -.0212 | .0021 | -.0048 |
| 19.19 | .9235 | .3880 | -.1081 | -.0035 | .0023 | -.0044 | 19.22 | .9736 | .4121 | -.1476 | -.0221 | .0033 | -.0072 |
| 21.23 | .9590 | .4382 | -.1305 | -.0043 | .0029 | -.0040 | 21.31 | 1.0311 | .4764 | -.1748 | -.0224 | .0054 | -.0096 |
| M = 0.85 | | | | | | | M = 0.85 | | | | | | |
| -4.15 | -.1923 | .0210 | .1193 | .0000 | .0005 | .0009 | -4.14 | -.1914 | .0389 | .1330 | -.0335 | -.0050 | .0143 |
| -1.94 | -.0045 | .0166 | .0754 | .0001 | .0004 | .0010 | -1.92 | .0091 | .0341 | .0840 | -.0335 | -.0048 | .0164 |
| 0.30 | .1958 | .0204 | .0402 | .0000 | .0001 | .0011 | 0.33 | .2088 | .0379 | .0437 | -.0332 | -.0047 | .0148 |
| 2.56 | .4095 | .0373 | -.0030 | -.0003 | -.0002 | .0027 | 2.58 | .4312 | .0540 | -.0069 | -.0318 | -.0045 | .0157 |
| 4.78 | .5945 | .0762 | -.0446 | -.0007 | -.0006 | .0018 | 4.85 | .6621 | .0930 | -.0814 | -.0299 | -.0039 | .0135 |
| 6.89 | .6698 | .1149 | -.0443 | .0013 | .0004 | .0015 | 6.99 | .7729 | .1374 | -.1015 | -.0259 | -.0007 | .0076 |
| 8.95 | .7011 | .1582 | -.0290 | -.0004 | .0001 | .0002 | 9.02 | .7780 | .1770 | -.0835 | -.0247 | .0006 | .0042 |
| 11.01 | .7325 | .1948 | -.0176 | -.0010 | .0000 | -.0004 | 11.07 | .8010 | .2164 | -.0690 | -.0207 | .0009 | .0027 |
| 13.08 | .7759 | .2393 | -.0293 | -.0021 | .0006 | .0048 | 13.12 | .8345 | .2608 | -.0784 | -.0219 | .0011 | -.0004 |
| 15.12 | .8094 | .2811 | -.0530 | -.0028 | .0013 | -.0038 | 15.16 | .8679 | .3061 | -.1007 | -.0209 | .0013 | .0008 |
| 17.19 | .8703 | .3361 | -.0871 | -.0037 | .0037 | -.0070 | 17.24 | .9325 | .3645 | -.1330 | -.0209 | .0023 | -.0036 |
| 19.29 | .9422 | .3989 | -.1169 | -.0031 | .0036 | -.0075 | 19.34 | 1.0017 | .4295 | -.1613 | -.0218 | .0041 | -.0061 |
| 21.37 | 1.0023 | .4617 | -.1412 | -.0038 | .0039 | -.0073 | 21.43 | 1.0678 | .4995 | -.1907 | -.0223 | .0057 | -.0076 |
| M = 0.90 | | | | | | | M = 0.90 | | | | | | |
| -4.19 | -.2156 | .0233 | .1392 | -.0003 | .0004 | .0039 | -4.18 | -.2236 | .0430 | .1576 | -.0329 | -.0046 | .0172 |
| -1.92 | .0032 | .0177 | .0866 | -.0003 | .0003 | .0030 | -1.90 | .0074 | .0357 | .0968 | -.0326 | -.0048 | .0178 |
| 0.37 | .2389 | .0269 | .0243 | -.0002 | .0003 | .0034 | 0.38 | .2471 | .0452 | .0247 | -.0319 | -.0044 | .0170 |
| 2.61 | .4441 | .0515 | -.0327 | -.0004 | .0000 | .0017 | 2.68 | .5037 | .0716 | -.0671 | -.0297 | -.0031 | .0137 |
| 4.82 | .6001 | .0877 | -.0571 | -.0004 | .0001 | .0014 | 4.86 | .6693 | .1086 | -.1297 | -.0349 | -.0025 | .0132 |
| 6.95 | .6785 | .1228 | -.0488 | .0006 | .0004 | .0010 | 7.05 | .7839 | .1503 | -.1132 | -.0264 | -.0008 | .0090 |
| 9.01 | .6997 | .1602 | -.0295 | -.0004 | .0004 | .0026 | 9.09 | .7891 | .1863 | -.0836 | -.0210 | .0008 | .0039 |
| 11.10 | .7494 | .2028 | -.0273 | -.0005 | .0000 | .0011 | 11.17 | .8297 | .2294 | -.0748 | -.0200 | .0009 | .0022 |
| 13.21 | .8172 | .2535 | -.0357 | -.0018 | .0003 | .0010 | 13.31 | .9167 | .2927 | -.0883 | -.0191 | .0009 | .0015 |
| 15.27 | .8754 | .3072 | -.0628 | -.0026 | .0009 | -.0005 | 15.35 | .9458 | .3390 | -.1089 | -.0197 | .0012 | -.0019 |
| 17.37 | .9439 | .3676 | -.0991 | -.0023 | .0009 | -.0020 | 17.40 | .9934 | .3939 | -.1452 | -.0194 | .0025 | -.0035 |
| 19.44 | 1.0009 | .4287 | -.1361 | -.0035 | .0019 | -.0059 | 19.51 | 1.0725 | .4672 | -.1875 | -.0199 | .0040 | -.0066 |
| 21.55 | 1.0744 | .5006 | -.1659 | -.0039 | .0031 | -.0063 | 21.55 | 1.0949 | .5175 | -.2038 | -.0207 | .0054 | -.0070 |
| M = 0.96 | | | | | | | M = 0.96 | | | | | | |
| -4.15 | -.1997 | .0424 | .1620 | -.0005 | .0010 | .0033 | -4.15 | -.2116 | .0577 | .1791 | -.0303 | -.0018 | .0100 |
| -1.91 | -.0055 | .0377 | .0966 | -.0014 | .0007 | .0047 | -1.90 | .0072 | .0510 | .0914 | -.0291 | -.0020 | .0117 |
| 0.35 | .2086 | .0440 | .0226 | .018- | .0002 | .0051 | 0.37 | .2408 | .0633 | -.0021 | -.0292 | -.0010 | .0098 |
| 2.60 | .4181 | .0691 | -.0485 | .0001 | -.0001 | .0036 | 2.63 | .4660 | .0904 | -.0863 | -.0289 | .0013 | .1163 |
| 4.87 | .6199 | .1074 | -.0995 | -.0003 | .0000 | .0025 | 4.90 | .6760 | .1287 | -.1519 | -.0248 | .0000 | .0060 |
| 7.03 | .7285 | .1440 | -.1020 | .0000 | .0001 | .0033 | 7.10 | .8073 | .1694 | -.1569 | -.0241 | .0006 | .0059 |
| 9.24 | .8851 | .2111 | -.1477 | .0008 | .0001 | -.0009 | 9.20 | .8447 | .2041 | -.1301 | -.0158 | .0012 | .0002 |
| 11.40 | .9505 | .2658 | -.1146 | .0013 | -.0002 | -.0013 | 11.48 | 1.0839 | .3112 | -.2447 | -.0157 | .0017 | -.0035 |
| 13.50 | .9937 | .3197 | -.0895 | -.0012 | -.0003 | .0004 | 13.58 | 1.0831 | .3601 | -.1956 | -.0160 | .0020 | -.0023 |

TABLE I.- DATA OBTAINED WITH AILERONS AND SPOILERS

ON MODEL WITH ORIGINAL WINGS - Concluded

| Ailerons deflected equally and oppositely 7.5° each. | | | | | | | Ailerons deflected equally and oppositely 15° each. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_m$ | $C_l$ | $C_n$ | $C_Y$ | $\alpha$ | $C_L$ | $C_D$ | $C_m$ | $C_l$ | $C_n$ | $C_Y$ |
| $M = 0.60$ | | | | | | | $M = 0.60$ | | | | | | |
| -4.09 | -.1610 | .0228 | .0983 | .0172 | .0026 | -.0046 | -4.09 | -.1689 | .0283 | .1006 | .0311 | .0046 | -.0154 |
| -1.97 | .0013 | .0186 | .0602 | .0173 | .0028 | .0042 | -1.98 | -.0067 | .0244 | .0607 | .0316 | .0044 | -.0173 |
| 0.15 | .1442 | .0185 | .0305 | .0171 | .0025 | -.0060 | 0.15 | .1473 | .0259 | .0317 | .0307 | .0042 | -.0155 |
| 2.27 | .3053 | .0285 | -.0022 | .0161 | .0022 | -.0066 | 2.27 | .3083 | .0330 | -.0001 | .0295 | .0041 | -.0159 |
| 4.40 | .4767 | .0478 | -.0330 | .0156 | .0014 | -.0068 | 4.43 | .5116 | .0543 | -.0310 | .0286 | .0036 | -.0138 |
| 6.54 | .6347 | .0875 | -.0614 | .0118 | -.0007 | -.0012 | 6.53 | .6349 | .0880 | -.0629 | .0264 | .0026 | -.0128 |
| 8.60 | .7238 | .1362 | -.0655 | .0093 | .0000 | -.0006 | 8.60 | .7268 | .1404 | -.0647 | .0210 | .0010 | -.0103 |
| 10.66 | .7521 | .1807 | -.0353 | .0071 | .0001 | -.0023 | 10.64 | .7533 | .1819 | -.0398 | .0204 | .0007 | .069- |
| 12.70 | .7742 | .2216 | -.0107 | .0102 | .0003 | -.0029 | 12.75 | .7677 | .2243 | .0845 | .0193 | .0010 | .0050 |
| 14.71 | .7834 | .2573 | -.0207 | .0116 | -.0005 | -.0041 | 14.71 | .7861 | .2641 | -.0228 | .0221 | -.0005 | -.0044 |
| 16.74 | .8261 | .3040 | -.0569 | .0117 | -.0003 | -.0061 | 16.73 | .8150 | .3049 | -.0546 | .0212 | -.0006 | -.0080 |
| 18.78 | .8761 | .3539 | -.0804 | .0097 | .0003 | -.0083 | 18.77 | .8680 | .3566 | -.0791 | .0185 | .0002 | -.0083 |
| 20.83 | .9398 | .4128 | -.1114 | .0066 | .0033 | -.0110 | 20.84 | .9447 | .4210 | -.1075 | .0152 | .0030 | -.0106 |
| $M = 0.80$ | | | | | | | $M = 0.80$ | | | | | | |
| -4.14 | -.1818 | .0215 | .1110 | .0177 | .0025 | -.0075 | -4.14 | -.1841 | .0284 | .1156 | .0307 | .0050 | -.0119 |
| -1.94 | -.0002 | .0172 | .0734 | .0178 | .0023 | -.0090 | -1.94 | -.0023 | .0234 | .0749 | .0305 | .0047 | -.0125 |
| 0.26 | .1810 | .0206 | .0382 | .0170 | .0022 | -.0076 | 0.25 | .1788 | .0249 | .0396 | .0293 | .0044 | -.0125 |
| 2.47 | .3665 | .0325 | .0005 | .0157 | .0022 | -.0091 | 2.48 | .3765 | .0373 | .0023 | .0276 | .0042 | -.0113 |
| 4.68 | .5383 | .0627 | -.0365 | .0154 | .0023 | -.0105 | 4.69 | .5688 | .0677 | -.0384 | .0277 | .0042 | -.0118 |
| 6.81 | .6649 | .1064 | -.0491 | .0147 | .0017 | -.0071 | 6.84 | .6841 | .1139 | -.0501 | .0248 | .0032 | -.0096 |
| 8.88 | .7023 | .1910 | -.0346 | .0121 | .0007 | -.0063 | 8.90 | .7237 | .1564 | -.0392 | .0186 | .0016 | -.0040 |
| 10.92 | .7128 | .1871 | -.0159 | .0114 | .0008 | -.0064 | 10.93 | .7257 | .1955 | -.0095 | .0204 | .0023 | -.0068 |
| 12.98 | .7509 | .2296 | -.0171 | .0118 | .0008 | -.0074 | 12.96 | .7410 | .2337 | -.0097 | .0233 | .0024 | -.0066 |
| 14.99 | .7677 | .2664 | -.0493 | .0141 | -.0004 | -.0074 | 14.99 | .7580 | .2693 | -.0414 | .0248 | .0002 | -.0040 |
| 17.06 | .8340 | .3193 | -.0756 | .0135 | -.0012 | -.0140 | 17.06 | .8292 | .3246 | -.0684 | .0243 | -.0010 | -.0040 |
| 19.14 | .8946 | .3749 | -.1003 | .0113 | .0001 | -.0162 | 19.15 | .8966 | .3830 | -.0956 | .0221 | .0003 | -.0051 |
| 21.23 | .9595 | .4374 | -.1236 | .0101 | .0015 | -.0115 | 21.23 | .9648 | .4470 | -.1192 | .0195 | .0021 | -.0109 |
| $M = 0.85$ | | | | | | | $M = 0.85$ | | | | | | |
| -4.17 | -.2048 | .0221 | .1227 | .0176 | .0025 | -.0100 | -4.15 | -.1973 | .0270 | .1255 | .0295 | .0049 | -.0104 |
| -1.95 | -.0141 | .0170 | .0788 | .0176 | .0025 | -.0098 | -1.92 | .0109 | .0219 | .0776 | .0295 | .0047 | -.0118 |
| 0.28 | .1803 | .0208 | .0407 | .0175 | .0022 | -.0114 | 0.32 | .2045 | .0267 | .0425 | .0295 | .0045 | -.0168 |
| 2.52 | .3833 | .0365 | -.0005 | .0162 | .0021 | -.0108 | 2.58 | .4297 | .0444 | -.0046 | .0274 | .0044 | -.0118 |
| 4.75 | .5847 | .0750 | -.0463 | .0153 | .0021 | -.0120 | 4.79 | .6130 | .0817 | -.0511 | .0282 | .0052 | -.0132 |
| 6.88 | .6496 | .1158 | -.0464 | .0145 | .0017 | -.0112 | 6.90 | .6925 | .1216 | -.0520 | .0226 | .0031 | -.0091 |
| 8.94 | .6938 | .1549 | -.0282 | .0153 | .0015 | -.0086 | 8.96 | .7068 | .1625 | -.0286 | .0237 | .0030 | -.0085 |
| 11.01 | .7329 | .1971 | -.0142 | .0112 | .0011 | -.0077 | 11.06 | .7624 | .2105 | -.0135 | .0193 | .0031 | -.0059 |
| 13.05 | .7551 | .2350 | -.0201 | .0111 | .0016 | -.0093 | 13.06 | .7633 | .2441 | -.0172 | .0218 | .0029 | -.0064 |
| 15.10 | .8050 | .2825 | -.0536 | .0140 | -.0004 | -.0070 | 15.10 | .8044 | .2891 | -.0519 | .0239 | -.0003 | -.0045 |
| 17.16 | .8557 | .3315 | -.0829 | .0135 | -.0010 | -.0077 | 17.16 | .8551 | .3386 | -.0811 | .0230 | -.0015 | -.0027 |
| 19.23 | .9112 | .3873 | -.1125 | .0113 | -.0005 | -.0106 | 19.26 | .9270 | .3996 | -.1090 | .0211 | -.0003 | -.0039 |
| 21.34 | .9883 | .4570 | -.1360 | .0099 | .0014 | -.0123 | 21.36 | .9987 | .4687 | -.1320 | .0190 | .0019 | -.0069 |
| $M = 0.90$ | | | | | | | $M = 0.90$ | | | | | | |
| -4.21 | -.2398 | .0259 | .1428 | .0174 | .0024 | -.0099 | -4.19 | -.2204 | .0306 | .1448 | .0288 | .0046 | -.0081 |
| -1.92 | -.0012 | .0190 | .0850 | .0171 | .0019 | -.0112 | -1.91 | .0096 | .0245 | .0868 | .0285 | .0046 | -.0106 |
| 0.36 | .2249 | .0274 | .0272 | .0167 | .0018 | -.0104 | 0.29 | .1939 | .0333 | .0253 | .0287 | .0040 | -.0094 |
| 2.59 | .4320 | .0511 | -.0281 | .0141 | .0021 | -.0105 | 2.47 | .4603 | .0565 | -.2081 | .0228 | .0034 | -.0282 |
| 4.79 | .5824 | .0859 | -.0595 | .0144 | .0014 | -.0090 | 4.84 | .6271 | .0962 | -.0702 | .0294 | .0036 | -.0079 |
| 6.92 | .6664 | .1205 | -.0499 | .0153 | .0012 | -.0098 | 6.96 | .6965 | .1319 | -.0541 | .0233 | .0034 | -.0064 |
| 9.01 | .7031 | .1651 | -.0297 | .0124 | .0013 | -.0075 | 9.01 | .7122 | .1699 | -.0279 | .0183 | .0026 | -.0041 |
| 11.08 | .7449 | .2039 | -.0221 | .0109 | .0013 | -.0077 | 11.15 | .7947 | .2222 | -.0332 | .0171 | .0027 | -.0027 |
| 13.18 | .8094 | .2546 | -.0299 | .0099 | .0015 | -.0102 | 13.21 | .8296 | .2673 | -.0277 | .0168 | .0030 | -.0039 |
| 15.29 | .8889 | .3166 | -.0618 | .0099 | .0013 | -.0099 | 15.24 | .8637 | .3125 | -.0600 | .0215 | -.0002 | .0013 |
| 17.31 | .9154 | .3603 | -.0945 | .0110 | .0002 | -.0080 | 17.31 | .9133 | .3664 | -.0957 | .0213 | -.0010 | -.0015 |
| 19.37 | .9600 | .4130 | -.1287 | .0102 | -.0008 | -.0083 | 19.40 | .9798 | .4297 | -.1289 | .0190 | -.0012 | .0056 |
| 21.49 | 1.0411 | .4887 | -.1564 | .0079 | .0014 | -.0117 | 21.53 | 1.0604 | .5040 | -.1551 | .0160 | .0015 | -.0021 |
| $M = 0.96$ | | | | | | | $M = 0.96$ | | | | | | |
| -4.19 | -.2234 | .0436 | .1634 | .0110 | .0013 | -.0058 | -4.17 | -.2132 | .0490 | .1658 | .0194 | .0027 | -.0031 |
| -1.93 | -.0144 | .0368 | .0945 | .0103 | .0008 | -.0046 | -1.90 | .0084 | .0453 | .0882 | .0194 | .0020 | -.0017 |
| 0.32 | .1987 | .0468 | .0194 | .0094 | -.0001 | -.0043 | 0.28 | .1816 | .0561 | .0129 | .0173 | .0008 | -.0007 |
| 2.57 | .4068 | .0717 | -.0510 | .0113 | .0000 | -.0066 | 2.59 | .4290 | .0739 | -.0645 | .0172 | .0009 | -.0025 |
| 4.82 | .5964 | .1042 | -.0881 | .0152 | .0003 | -.0050 | 4.85 | .6183 | .1153 | -.1109 | .0205 | .0007 | -.0021 |
| 7.00 | .7085 | .1430 | -.0862 | .0106 | .0002 | -.0036 | 7.05 | .7508 | .1580 | -.1264 | .0179 | .0011 | -.0027 |
| 9.19 | .7984 | .1891 | -.0551 | .0116 | .0005 | .0002 | 9.13 | .8021 | .1953 | -.1216 | .0154 | .0016 | -.0037 |
| 11.39 | .9661 | .2678 | -.1279 | .0080 | -.0005 | -.0018 | 11.33 | .9409 | .2711 | -.1631 | .0140 | .0003 | -.0043 |
| 13.58 | 1.0670 | .3466 | -.1255 | .0074 | -.0012 | -.0049 | 13.54 | 1.0488 | .3473 | -.1271 | .0135 | -.0006 | -.0010 |

TABLE II.- DATA OBTAINED WITH JET CONTROLS INCLUDING WING-TIP INLETS AND SMALL PLENUM CHAMBER IN WINGS

| Jets closed. | | | | | | | Thirty-nine 0.063-inch-diameter jets open. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_m$ | $C_l$ | $C_n$ | $C_Y$ | $\alpha$ | $C_L$ | $C_D$ | $C_m$ | $C_l$ | $C_n$ | $C_Y$ |
| $M = 0.60$ | | | | | | | $M = 0.60$ | | | | | | |
| -4.10 | -.2005 | .0388 | .1196 | -.0027 | -.0006 | .0012 | -4.11 | -.2030 | .0398 | .1201 | -.0123 | -.0024 | .0068 |
| -1.98 | -.0217 | .0329 | .0688 | -.0028 | -.0010 | -.0014 | -1.98 | -.0204 | .0343 | .0692 | -.0128 | -.0024 | .0082 |
| 0.15 | .1566 | .0360 | .0253 | -.0029 | -.0013 | -.0031 | 0.15 | .1584 | .0373 | .0247 | -.0127 | -.0035 | .0043 |
| 2.28 | .3350 | .0476 | -.0264 | -.0028 | -.0012 | -.0059 | 2.30 | .3438 | .0487 | -.0233 | -.0121 | -.0025 | .0043 |
| 4.43 | .5190 | .0714 | -.0633 | -.0024 | -.0011 | -.0047 | 4.42 | .5177 | .0725 | -.0648 | -.0117 | -.0024 | .0028 |
| 6.56 | .6793 | .1150 | -.0983 | -.0022 | -.0014 | -.0055 | 6.54 | .6751 | .1164 | -.1034 | -.0100 | -.0022 | .0016 |
| 8.64 | .7784 | .1649 | -.1077 | -.0029 | -.0017 | -.0135 | 8.64 | .7812 | .1679 | -.1129 | -.0116 | -.0023 | .0015 |
| 10.69 | .8096 | .2120 | -.0662 | -.0029 | -.0011 | .0002 | 10.71 | .8232 | .2170 | -.0814 | -.0105 | -.0029 | -.0038 |
| 12.74 | .8397 | .2607 | -.0514 | -.0024 | -.0014 | -.0073 | 12.74 | .8506 | .2634 | -.0644 | -.0080 | -.0014 | -.0030 |
| 14.75 | .8571 | .3022 | -.0680 | -.0023 | -.0014 | -.0072 | 14.75 | .8715 | .3078 | -.0845 | -.0071 | -.0015 | -.0052 |
| 16.79 | .9076 | .3531 | -.1023 | -.0038 | -.0006 | -.0089 | 16.80 | .9147 | .3573 | -.1153 | -.0085 | -.0005 | -.0065 |
| 18.85 | .9689 | .4125 | -.1338 | -.0043 | -.0001 | -.0120 | 18.83 | .9630 | .4101 | -.1432 | -.0097 | .0000 | -.0074 |
| 20.88 | 1.0106 | .4670 | -.1608 | -.0061 | .0017 | -.0164 | 20.88 | 1.0143 | .4708 | -.1711 | -.0110 | .0011 | -.0101 |
| $M = 0.80$ | | | | | | | $M = 0.80$ | | | | | | |
| -4.18 | -.2222 | .0399 | .1395 | -.0029 | -.0008 | -.0060 | -4.18 | -.2297 | .0408 | .1407 | -.0130 | -.0019 | .0019 |
| -1.95 | -.0168 | .0337 | .0804 | -.0025 | -.0011 | -.0060 | -1.96 | -.0120 | .0344 | .0777 | -.0130 | -.0019 | .0029 |
| 0.26 | .1926 | .0382 | .0256 | -.0030 | -.0012 | -.0054 | 0.26 | .1928 | .0403 | .0259 | -.0128 | -.0021 | .0024 |
| 2.48 | .3918 | .0550 | -.0255 | -.0030 | -.0014 | -.0059 | 2.50 | .4090 | .0581 | -.0283 | -.0131 | -.0022 | .0044 |
| 4.69 | .5823 | .0879 | -.0690 | -.0029 | -.0020 | -.0029 | 4.70 | .5975 | .0920 | -.0769 | -.0127 | -.0027 | .0055 |
| 6.86 | .7152 | .1345 | -.0747 | -.0035 | -.0022 | -.0022 | 6.85 | .7270 | .1390 | -.1004 | -.0117 | -.0023 | .0039 |
| 8.96 | .7826 | .1868 | -.0772 | -.0034 | -.0009 | -.0082 | 8.97 | .8026 | .1922 | -.0951 | -.0053 | -.0003 | -.0036 |
| 11.00 | .7966 | .2292 | -.0596 | -.0019 | -.0015 | -.0071 | 11.00 | .8065 | .2329 | -.0749 | -.0076 | -.0017 | .0003 |
| 13.06 | .8437 | .2803 | -.0705 | -.0040 | -.0013 | -.0105 | 13.05 | .8402 | .2779 | -.0827 | -.0096 | -.0014 | -.0015 |
| 15.10 | .8802 | .3254 | -.1010 | -.0044 | -.0010 | -.0099 | 15.11 | .8945 | .3315 | -.1169 | -.0097 | -.0008 | -.0012 |
| 17.18 | .9482 | .3859 | -.1396 | -.0049 | -.0005 | -.0126 | 17.17 | .9555 | .3899 | -.1532 | -.0107 | -.0001 | -.0023 |
| 19.23 | 1.0030 | .4440 | -.1814 | -.0057 | .0003 | -.0132 | 19.24 | 1.0179 | .4513 | -.2011 | -.0101 | -.0007 | -.0025 |
| 21.33 | 1.0749 | .5171 | -.2155 | -.0058 | .0027 | -.0203 | 21.33 | 1.0819 | .5203 | -.2198 | -.0112 | .0028 | -.0141 |
| $M = 0.85$ | | | | | | | $M = 0.85$ | | | | | | |
| -4.18 | -.2262 | .0392 | .1444 | -.0040 | -.0006 | -.0052 | -4.20 | -.2369 | .0422 | .1514 | -.0133 | -.0020 | .0017 |
| -1.95 | -.0119 | .0344 | .0788 | -.0039 | -.0006 | -.0038 | -1.94 | -.0074 | .0320 | .0807 | -.0129 | -.0021 | .0038 |
| 0.32 | .2194 | .0421 | .0208 | -.0034 | -.0008 | -.0037 | 0.33 | .2258 | .0402 | .0186 | -.0134 | -.0025 | .0057 |
| 2.57 | .4365 | .0627 | -.0383 | -.0033 | -.0008 | -.0053 | 2.58 | .4578 | .0692 | -.0463 | -.0139 | -.0023 | .0048 |
| 4.79 | .6200 | .0991 | -.0803 | -.0046 | -.0023 | -.0015 | 4.81 | .6455 | .1015 | -.0921 | -.0143 | -.0034 | .0045 |
| 6.94 | .7483 | .1461 | -.0993 | -.0038 | -.0011 | -.0049 | 6.97 | .7738 | .1516 | -.1108 | -.0121 | -.0020 | .0037 |
| 9.01 | .7724 | .1890 | -.0792 | -.0049 | -.0008 | -.0031 | 9.05 | .8096 | .1955 | -.0945 | -.0108 | -.0016 | .0039 |
| 11.08 | .8190 | .2381 | -.0754 | .0013 | .0003 | -.0070 | 11.11 | .8352 | .2411 | -.0837 | -.0085 | -.0016 | .0019 |
| 13.15 | .8610 | .2870 | -.0791 | -.0043 | -.0003 | -.0069 | 13.15 | .8726 | .2876 | -.0984 | -.0098 | -.0013 | -.0007 |
| 15.22 | .9153 | .3406 | -.1181 | -.0049 | -.0002 | -.0050 | 15.23 | .9350 | .3449 | -.1377 | -.0097 | -.0009 | -.0013 |
| 17.27 | .9667 | .3973 | -.1605 | -.0054 | .0009 | -.0072 | 17.30 | 1.0026 | .4101 | -.1811 | -.0097 | -.0003 | -.0035 |
| 19.36 | 1.0389 | .4652 | -.2039 | -.0056 | .0011 | -.0094 | 19.37 | 1.0584 | .4698 | -.2219 | -.0093 | .0000 | -.0080 |
| 21.45 | 1.1108 | .5386 | -.2375 | -.0093 | .0058 | -.0158 | 21.48 | 1.1318 | .5460 | -.2467 | -.0161 | .0058 | -.0106 |
| $M = 0.90$ | | | | | | | $M = 0.90$ | | | | | | |
| -4.21 | -.2610 | .0468 | .1795 | -.0039 | -.0001 | -.0009 | -4.20 | -.2570 | .0466 | .1875 | -.0131 | -.0014 | .0020 |
| -1.92 | -.0055 | .0397 | .0922 | -.0033 | -.0005 | .0012 | -1.92 | .0046 | .0366 | .0877 | -.0134 | -.0020 | .0029 |
| 0.36 | .2385 | .0474 | .0075 | -.0037 | -.0007 | .0022 | 0.39 | .2671 | .0491 | -.0023 | -.0138 | -.0022 | .0034 |
| 2.60 | .4486 | .0741 | -.0524 | -.0031 | -.0007 | -.0021 | 2.62 | .4732 | .0764 | -.0663 | -.0123 | -.0021 | .0032 |
| 4.84 | .6345 | .1128 | -.0965 | -.0060 | -.0016 | -.0001 | 4.86 | .6586 | .1152 | -.1086 | -.0147 | -.0031 | .0042 |
| 7.03 | .7697 | .1598 | -.1097 | -.0030 | -.0011 | -.0025 | 7.03 | .7747 | .1583 | -.1189 | -.0121 | -.0024 | .0009 |
| 9.12 | .8210 | .2074 | -.0916 | -.0089 | -.0014 | -.0007 | 9.13 | .8276 | .2076 | -.1028 | -.0121 | -.0023 | -.0010 |
| 11.20 | .8495 | .2518 | -.0797 | -.0028 | -.0005 | -.0046 | 11.21 | .8739 | .2566 | -.0995 | -.0089 | -.0015 | -.0034 |
| 13.30 | .9096 | .3054 | -.0864 | -.0035 | -.0002 | -.0069 | 13.31 | .9339 | .3118 | -.1105 | -.0094 | -.0010 | -.0040 |
| 15.36 | .9672 | .3651 | -.1298 | -.0045 | -.0001 | -.0059 | 15.41 | 1.0181 | .3797 | -.1487 | -.0099 | -.0004 | -.0078 |
| 17.43 | 1.0360 | .4297 | -.1891 | -.0053 | .0007 | -.0104 | 17.46 | 1.0647 | .4389 | -.2058 | -.0104 | .0009 | -.0110 |
| 19.51 | 1.0999 | .4965 | -.2273 | -.0055 | .0015 | -.0109 | 19.53 | 1.1266 | .5085 | -.2551 | -.0127 | .0022 | -.0130 |
| 21.62 | 1.1767 | .5773 | -.2741 | -.0090 | .0044 | -.0166 | 21.65 | 1.2030 | .5899 | -.2908 | -.0151 | .0053 | -.0173 |
| $M = 0.96$ | | | | | | | $M = 0.96$ | | | | | | |
| -4.18 | -.2357 | .0665 | .1922 | -.0027 | .0003 | -.0056 | -4.17 | -.2319 | .0601 | .1900 | -.0135 | -.0008 | .0038 |
| -1.91 | -.0057 | .0560 | .0995 | -.0034 | -.0006 | -.0038 | -1.91 | .0021 | .0559 | .0927 | -.0131 | -.0012 | .0030 |
| 0.37 | .2340 | .0639 | .0070 | -.0038 | -.0015 | -.0023 | 0.36 | .2370 | .0700 | -.0075 | -.0148 | -.0018 | .0056 |
| 2.62 | .4417 | .0924 | -.0619 | -.0014 | -.0009 | -.0034 | 2.57 | .4144 | .0880 | -.0661 | -.0130 | -.0016 | .0044 |
| 4.84 | .6169 | .1299 | -.1210 | -.0018 | -.0012 | -.0092 | 4.86 | .6293 | .1268 | -.1194 | -.0099 | -.0015 | .0020 |
| 7.11 | .8378 | .1936 | -.1996 | -.0038 | -.0013 | -.0100 | 7.10 | .8209 | .1854 | -.1833 | -.0098 | -.0015 | .0012 |
| 9.37 | 1.0238 | .2676 | -.2369 | -.0057 | -.0012 | -.0089 | 9.35 | 1.0315 | .2761 | -.2784 | -.0127 | -.0016 | -.0036 |
| 11.47 | 1.0908 | .3272 | -.2572 | -.0042 | -.0014 | -.0107 | 11.53 | 1.1561 | .3457 | -.2988 | -.0121 | -.0019 | .0039 |
| 13.66 | 1.1897 | .4106 | -.2516 | -.0006 | -.0018 | -.0120 | | | | | | | |

TABLE II.- DATA OBTAINED WITH JET CONTROLS INCLUDING WING-TIP

INLETS AND SMALL PLENUM CHAMBER IN WINGS - Concluded

| Thirty-nine 0.081-inch-diameter jets open. | | | | | | |
|---|---|---|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_m$ | $C_l$ | $C_n$ | $C_Y$ |
| | | | M = 0.60 | | | |
| -4.11 | -.1995 | .0410 | .1174 | -.0155 | -.0027 | .0065 |
| -1.98 | -.0210 | .0357 | .0685 | -.0154 | -.0028 | .0081 |
| 0.15 | .1574 | .0393 | .0224 | -.0156 | -.0029 | .0139 |
| 2.30 | .3422 | .0510 | -.0245 | -.0148 | -.0025 | .0119 |
| 4.43 | .5217 | .0760 | -.0681 | -.0147 | -.0030 | -.0012 |
| 6.56 | .6900 | .1201 | -.1063 | -.0132 | -.0027 | .0130 |
| 8.65 | .7852 | .1710 | -.1157 | -.0139 | -.0026 | .0129 |
| 10.70 | .8234 | .2189 | -.0878 | -.0123 | -.0009 | .0074 |
| 12.74 | .8514 | .2649 | -.0707 | -.0085 | -.0009 | .0081 |
| 14.76 | .8790 | .3107 | -.0890 | -.0076 | -.0009 | .0061 |
| 16.80 | .9215 | .3607 | -.1198 | -.0102 | -.0001 | .0048 |
| 18.85 | .9820 | .4199 | -.1475 | -.0111 | .0010 | .0022 |
| 20.90 | 1.0335 | .4796 | -.1781 | -.0124 | .0024 | -.0008 |
| | | | M = 0.80 | | | |
| -4.19 | -.2291 | .0425 | .1386 | -.0154 | -.0022 | .0069 |
| -1.96 | -.0120 | .0360 | .0765 | -.0149 | -.0024 | .0093 |
| 0.42 | .3156 | .0431 | .0229 | -.0156 | -.0027 | .0113 |
| 2.50 | .4125 | .0598 | -.0323 | -.0152 | -.0029 | .0118 |
| 4.70 | .5977 | .0925 | -.0795 | -.0151 | -.0031 | .0130 |
| 6.86 | .7293 | .1402 | -.1028 | -.0131 | -.0026 | .0115 |
| 8.98 | .8124 | .1932 | -.1017 | -.0059 | -.0001 | .0023 |
| 11.00 | .8132 | .2546 | -.0798 | -.0089 | -.0018 | .0050 |
| 13.07 | .8535 | .2822 | -.0900 | -.0108 | -.0012 | .0030 |
| 15.12 | .9027 | .3347 | -.1249 | -.0113 | -.0010 | .0005 |
| 17.05 | .9596 | .3882 | -.3122 | -.0118 | -.0007 | -.0206 |
| 19.23 | 1.0119 | .4493 | -.2038 | -.0117 | -.0013 | -.0017 |
| 21.33 | 1.0823 | .5197 | -.2256 | -.0131 | .0035 | -.0148 |
| | | | M = 0.85 | | | |
| -4.19 | -.2331 | .0419 | .1499 | -.0157 | -.0022 | .0027 |
| -1.93 | -.0012 | .0355 | .0757 | -.0158 | -.0025 | .0032 |
| 0.31 | .2116 | .0430 | .0205 | -.0163 | -.0030 | .0045 |
| 2.58 | .4573 | .0673 | -.0490 | -.0166 | -.0030 | .0044 |
| 4.81 | .6450 | .1055 | -.0954 | -.0169 | -.0039 | .0065 |
| 6.96 | .7619 | .1514 | -.1126 | -.0157 | -.0036 | .0032 |
| 9.05 | .8151 | .1984 | -.1056 | -.0077 | -.0015 | -.0049 |
| 11.10 | .8377 | .2446 | -.0940 | -.0077 | -.0018 | -.0031 |
| 13.16 | .8800 | .2938 | -.1062 | -.0116 | -.0012 | -.0077 |
| 15.23 | .9395 | .3513 | -.1439 | -.0122 | -.0008 | -.0081 |
| 17.30 | 1.0016 | .4108 | -.1844 | -.0122 | -.0006 | -.0125 |
| 19.37 | 1.0490 | .4693 | -.2188 | -.0106 | -.0014 | -.0165 |
| 21.46 | 1.1266 | .5471 | -.2573 | -.0167 | .0060 | -.0231 |
| | | | M = 0.90 | | | |
| -4.21 | -.2573 | .0483 | .1801 | -.0162 | -.0021 | .0025 |
| -1.92 | -.0023 | .0403 | .0874 | -.0161 | -.0022 | .0039 |
| 0.37 | .2920 | .0515 | .0000 | -.0166 | -.0026 | .0070 |
| 2.61 | .4728 | .0802 | -.0707 | -.0157 | -.0029 | .0060 |
| 4.85 | .6481 | .1173 | -.1118 | -.0170 | -.0035 | .0060 |
| 7.03 | .7786 | .1635 | -.1251 | -.0154 | -.0033 | .0034 |
| 9.13 | .8313 | .2121 | -.1088 | -.0150 | -.0027 | .0006 |
| 11.20 | .8738 | .2595 | -.1026 | -.0107 | -.0016 | -.0015 |
| 13.30 | .9339 | .3157 | -.1218 | -.0110 | -.0013 | -.0043 |
| 15.36 | .9912 | .3737 | -.1570 | -.0100 | -.0015 | -.0071 |
| 17.48 | 1.0845 | .4504 | -.2171 | -.0114 | -.0001 | -.0089 |
| 19.50 | 1.1076 | .5003 | -.2612 | -.0155 | .0032 | -.0093 |
| 21.62 | 1.1913 | .5851 | -.3024 | -.0184 | .0070 | -.0142 |
| | | | M = 0.96 | | | |
| -4.19 | -.2424 | .0664 | .1952 | -.0151 | -.0004 | .0055 |
| -1.92 | -.0020 | .0619 | .0951 | -.0146 | -.0013 | .0076 |
| 0.36 | .2475 | .0761 | -.0153 | -.0156 | -.0018 | .0091 |
| 2.62 | .4640 | .0996 | -.0898 | -.0165 | -.0021 | .0093 |
| 4.87 | .6501 | .1347 | -.1376 | -.0104 | -.0014 | .0053 |
| 7.09 | .8212 | .1884 | -.1944 | -.0133 | -.0017 | .0040 |
| 9.35 | 1.0345 | .2724 | -.2838 | -.0122 | -.0020 | .0012 |
| 11.52 | 1.1675 | .3592 | -.3407 | -.0156 | -.0032 | .0003 |

| Thirty-nine 0.099-inch-diameter jets open. | | | | | | |
|---|---|---|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_m$ | $C_l$ | $C_n$ | $C_Y$ |
| | | | M = 0.60 | | | |
| -4.10 | -.1997 | .0409 | .1192 | -.0164 | -.0024 | .0146 |
| -1.98 | -.0174 | .0365 | .0685 | -.0160 | -.0025 | .0140 |
| 0.16 | .1678 | .0398 | .0222 | -.0167 | -.0023 | .0180 |
| 2.30 | .3458 | .0511 | -.0238 | -.0161 | -.0024 | .0160 |
| 4.43 | .5298 | .0765 | -.0672 | -.0158 | -.0027 | .0143 |
| 6.55 | .6867 | .1196 | -.1037 | -.0143 | -.0025 | .0131 |
| 8.64 | .7788 | .1699 | -.1159 | -.0145 | -.0025 | .0128 |
| 10.69 | .8205 | .2177 | -.0880 | -.0128 | -.0005 | .0055 |
| 12.74 | .8521 | .2644 | -.0726 | -.0089 | -.0008 | .0020 |
| 14.78 | .8857 | .3143 | -.0930 | -.0090 | -.0010 | -.0002 |
| 16.80 | .9248 | .3628 | -.1219 | -.0113 | .0005 | -.0012 |
| 18.85 | .9792 | .4186 | -.1478 | -.0120 | .0011 | -.0037 |
| 20.89 | 1.0241 | .4753 | -.1803 | -.0136 | .0027 | -.0090 |
| | | | M = 0.80 | | | |
| -4.17 | -.2161 | .0410 | .1392 | -.0171 | -.0024 | .0005 |
| -1.95 | -.0059 | .0358 | .0770 | -.0168 | -.0024 | .0015 |
| 0.29 | .2059 | .0426 | .0221 | -.0171 | -.0029 | .0020 |
| 2.50 | .4098 | .0594 | -.0295 | -.0167 | -.0028 | .0029 |
| 4.70 | .6052 | .0943 | -.0804 | -.0161 | -.0032 | .0024 |
| 6.89 | .7510 | .1494 | -.1037 | -.0140 | -.0024 | .0011 |
| 8.97 | .8080 | .1939 | -.1029 | -.0083 | -.0007 | -.0072 |
| 11.00 | .8116 | .2349 | -.0833 | -.0106 | -.0020 | -.0047 |
| 13.07 | .8636 | .2863 | -.0954 | -.0120 | -.0014 | -.0068 |
| 15.12 | .8993 | .3331 | -.1294 | -.0121 | -.0012 | -.0086 |
| 17.18 | .9671 | .3939 | -.1671 | -.0135 | -.0001 | -.0093 |
| 19.22 | 1.0108 | .4494 | -.2074 | -.0129 | -.0009 | -.0114 |
| 21.33 | 1.0889 | .5201 | -.2293 | -.0143 | .0037 | -.0244 |
| | | | M = 0.85 | | | |
| -4.19 | -.2317 | .0430 | .1509 | -.0178 | -.0022 | .0066 |
| -1.95 | -.0109 | .0365 | .0830 | -.0177 | -.0021 | .0077 |
| 0.33 | .2250 | .0449 | .0174 | -.0176 | -.0024 | .0105 |
| 2.59 | .4711 | .0706 | -.0523 | -.0183 | -.0029 | .0127 |
| 4.81 | .6477 | .1061 | -.0958 | -.0186 | -.0038 | .0126 |
| 6.95 | .7541 | .1503 | -.1129 | -.0166 | -.0026 | .0106 |
| 9.04 | .8137 | .2001 | -.1089 | -.0095 | -.0011 | .0045 |
| 11.10 | .8419 | .2464 | -.0920 | -.0123 | -.0018 | .0059 |
| 13.15 | .8791 | .2934 | -.1095 | -.0131 | -.0009 | .0018 |
| 15.23 | .9432 | .3822 | -.1443 | -.0134 | -.0012 | .0017 |
| 17.28 | .9943 | .4095 | -.1878 | -.0139 | .0000 | .0005 |
| 19.37 | 1.0620 | .4760 | .223- | -.0122 | -.0001 | -.0068 |
| 21.45 | 1.1205 | .5445 | .634- | -.0167 | .0059 | -.0166 |
| | | | M = 0.90 | | | |
| -4.20 | -.2554 | .0490 | .1801 | -.0173 | -.0018 | .0107 |
| -1.92 | -.0002 | .0414 | .0872 | -.0177 | -.0020 | .0132 |
| 0.38 | .2647 | .0365 | -.0002 | -.0180 | -.0025 | .0129 |
| 2.58 | .4778 | .0811 | -.1255 | -.0172 | -.0027 | .0058 |
| 4.85 | .6503 | .1202 | -.1120 | -.0180 | -.0029 | .0130 |
| 7.04 | .7908 | .1682 | -.1312 | -.0185 | -.0032 | .0109 |
| 9.14 | .8439 | .2158 | -.1146 | -.0169 | -.0021 | .0070 |
| 11.21 | .8763 | .2617 | -.1083 | -.0118 | -.0011 | .0037 |
| 13.29 | .9267 | .3131 | -.1221 | -.0123 | -.0011 | .0025 |
| 15.40 | 1.0154 | .3836 | -.1600 | -.0109 | -.0015 | -.0025 |
| 17.45 | 1.0657 | .4431 | -.2174 | -.0120 | .0004 | -.0068 |
| 19.56 | 1.1542 | .5241 | -.2724 | -.0157 | .0025 | -.0068 |
| 21.64 | 1.1971 | .6165 | -.3030 | -.0197 | .0070 | -.0154 |
| | | | M = 0.96 | | | |
| -4.19 | -.2415 | .0649 | .1940 | -.0173 | -.0004 | .0031 |
| -1.90 | -.0009 | .0599 | .0975 | -.0162 | -.0011 | .0047 |
| 0.36 | .2389 | .0755 | -.0104 | -.0166 | -.0013 | .0043 |
| 2.61 | .4760 | .1056 | -.1212 | -.0200 | -.0019 | .0032 |
| 4.85 | .6316 | .1323 | -.1278 | -.0129 | -.0016 | .0020 |
| 7.10 | .8223 | .1882 | -.1768 | -.0148 | -.0018 | -.0001 |
| 9.32 | 1.0182 | .2688 | -.2795 | -.0157 | -.0018 | -.0040 |
| 11.46 | 1.0824 | .3296 | -.2590 | -.0157 | -.0017 | -.0026 |

TABLE III.- DATA OBTAINED WITH JET CONTROLS INCLUDING WING-TIP INLETS AND LARGE PLENUM CHAMBER IN WINGS

| Jets closed | | | | | | | Six inboard 0.125-inch-diameter jets open. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_m$ | $C_l$ | $C_n$ | $C_Y$ | $\alpha$ | $C_L$ | $C_D$ | $C_m$ | $C_l$ | $C_n$ | $C_Y$ |
| | | | M = 0.60 | | | | | | | M = 0.60 | | | |
| -6.22 | -.3440 | .0475 | .1565 | -.0020 | -.0001 | .0021 | -6.23 | -.3555 | .0554 | .1577 | -.0075 | -.0014 | .0060 |
| -4.10 | -.1821 | .0371 | .1057 | -.0019 | -.0002 | .0034 | -4.11 | -.1905 | .0415 | .1079 | -.0071 | -.0015 | .0034 |
| -1.98 | -.0136 | .0325 | .0568 | -.0021 | -.0003 | .0030 | -1.99 | -.0218 | .0360 | .0598 | -.0070 | -.0013 | .0072 |
| 0.15 | .1652 | .0353 | .0134 | -.0020 | -.0006 | .0034 | 0.15 | .1969 | .0390 | .0154 | -.0073 | -.0017 | .0054 |
| 2.28 | .3400 | .0464 | -.0309 | -.0021 | -.0007 | .0016 | 2.29 | .3425 | .0492 | -.0280 | -.0072 | -.0014 | .0059 |
| 4.42 | .5172 | .0707 | -.0687 | -.0022 | -.0004 | .0047 | 4.43 | .5235 | .0746 | -.0687 | -.0072 | -.0011 | .0067 |
| 6.54 | .6703 | .1151 | -.1019 | -.0024 | -.0005 | .0041 | 6.54 | .6700 | .1157 | -.1044 | -.0057 | .0000 | .0018 |
| 8.64 | .7703 | .1629 | -.1093 | -.0020 | -.0004 | .0043 | 8.63 | .7699 | .1654 | -.1112 | -.0071 | -.0017 | .0059 |
| 10.70 | .8115 | .2132 | -.0724 | -.0018 | -.0005 | .0015 | 10.69 | .8046 | .2146 | -.0796 | -.0057 | -.0010 | .0024 |
| 12.73 | .8318 | .2577 | -.0558 | -.0015 | -.0008 | .0019 | 12.73 | .8328 | .2568 | -.0618 | -.0040 | -.0010 | .0011 |
| 14.75 | .8558 | .3018 | -.0743 | -.0020 | -.0007 | -.0001 | 14.75 | .8496 | .3026 | -.0802 | -.0035 | -.0010 | -.0010 |
| 16.79 | .8970 | .3477 | -.1095 | -.0034 | -.0003 | -.0020 | 16.79 | .9003 | .3528 | -.1127 | -.0049 | -.0005 | -.0024 |
| 18.83 | .9549 | .4077 | -.1381 | -.0036 | -.0002 | -.0009 | 18.83 | .9580 | .4112 | -.1443 | -.0061 | .0004 | -.0055 |
| | | | M = 0.80 | | | | | | | M = 0.80 | | | |
| -6.37 | -.4074 | .0579 | .1832 | -.0020 | .0001 | .0013 | -6.37 | -.4062 | .0587 | .1823 | -.0076 | -.0008 | .0024 |
| -4.17 | -.2093 | .0386 | .1241 | -.0018 | -.0001 | -.0000 | -4.17 | -.2078 | .0413 | .1214 | -.0070 | -.0009 | .0023 |
| -1.95 | -.0087 | .0318 | .0680 | -.0023 | -.0002 | .0018 | -1.96 | -.0145 | .0359 | .0678 | -.0074 | -.0012 | .0029 |
| 0.25 | .1916 | .0382 | .0182 | -.0021 | -.0003 | .0030 | 0.25 | .1925 | .0395 | .0180 | -.0079 | -.0013 | .0042 |
| 2.50 | .4153 | .0543 | -.0347 | -.0026 | -.0007 | .0039 | 2.49 | .4039 | .0566 | -.0324 | -.0079 | -.0011 | .0041 |
| 4.69 | .5847 | .0865 | -.0761 | -.0008 | -.0003 | .0032 | 4.69 | .5877 | .0903 | -.0788 | -.0065 | -.0009 | .0028 |
| 6.84 | .7119 | .1323 | -.0933 | .0002 | -.0001 | .0024 | 6.84 | .7123 | .1362 | -.0981 | -.0062 | -.0009 | .0030 |
| 8.94 | .7673 | .1818 | -.0779 | -.0004 | -.0004 | .0022 | 8.94 | .7751 | .1865 | -.0857 | -.0063 | -.0014 | .0040 |
| 10.99 | .7874 | .2247 | -.0595 | -.0017 | -.0005 | .0009 | 10.99 | .7982 | .2301 | -.0673 | -.0041 | -.0008 | -.0000 |
| 13.04 | .8239 | .2710 | -.0689 | -.0020 | -.0002 | .0002 | 13.04 | .8322 | .2755 | -.0800 | -.0059 | -.0002 | -.0011 |
| 15.09 | .8743 | .3227 | -.1031 | -.0022 | -.0004 | -.0009 | 15.09 | .8775 | .3266 | -.1122 | -.0052 | -.0003 | -.0047 |
| 17.16 | .9311 | .3778 | -.1312 | -.0033 | .0000 | -.0010 | 17.16 | .9387 | .3824 | -.1404 | -.0065 | .0004 | -.0047 |
| 19.24 | 1.0055 | .4454 | -.1736 | -.0042 | .0007 | -.0041 | 19.23 | 1.0038 | .4462 | -.1797 | -.0081 | .0018 | -.0061 |
| | | | M = 0.85 | | | | | | | M = 0.85 | | | |
| -6.41 | -.4327 | .0606 | .2025 | -.0024 | -.0002 | .0021 | -6.41 | -.4219 | .0522 | .1972 | -.0083 | -.0009 | .0052 |
| -4.18 | -.2185 | .0403 | .1389 | -.0013 | .0001 | .0015 | -4.17 | -.2113 | .0378 | .1352 | -.0076 | -.0006 | .0047 |
| -1.94 | -.0064 | .0345 | .0761 | -.0018 | .0001 | .0033 | -1.94 | -.0057 | .0319 | .0771 | -.0075 | -.0010 | .0058 |
| 0.31 | .2074 | .0384 | .0181 | -.0019 | -.0002 | .0032 | 0.33 | .2240 | .0349 | .0201 | -.0081 | -.0012 | .0086 |
| 2.56 | .4338 | .0611 | -.0380 | -.0013 | -.0003 | .0035 | 2.58 | .4487 | .0580 | -.0390 | -.0074 | -.0008 | .0060 |
| 4.79 | .6227 | .0988 | -.0802 | .0025 | .0005 | .0002 | 4.81 | .6383 | .0967 | -.0847 | -.0034 | .0002 | .0048 |
| 6.92 | .7247 | .1425 | -.0924 | .0025 | .0004 | .0009 | 6.93 | .7422 | .1439 | -.1025 | -.0055 | -.0008 | .0048 |
| 9.01 | .7705 | .1888 | -.0755 | -.0004 | -.0002 | .0011 | 9.02 | .7942 | .1919 | -.1019 | -.0053 | -.0009 | .0029 |
| 11.08 | .8020 | .2337 | -.0612 | -.0015 | -.0008 | .0007 | 11.10 | .8268 | .2382 | -.0689 | -.0052 | -.0004 | .0039 |
| 13.15 | .8524 | .2844 | -.0729 | -.0021 | -.0003 | -.0001 | 13.16 | .8687 | .2863 | -.0853 | -.0067 | .0000 | .0012 |
| 15.22 | .9172 | .3428 | -.1153 | -.0026 | -.0004 | -.0022 | 15.23 | .9292 | .3434 | -.1219 | -.0066 | .0002 | .0010 |
| 17.28 | .9731 | .4005 | -.1559 | -.0034 | .0002 | -.0029 | 17.29 | .9855 | .4013 | -.1619 | -.0068 | .0004 | -.0009 |
| 19.37 | 1.0423 | .4681 | -.1977 | -.0043 | .0017 | -.0097 | 19.37 | 1.0506 | .4678 | -.2043 | -.0079 | .0025 | -.0040 |
| | | | M = 0.90 | | | | | | | M = 0.90 | | | |
| -6.45 | -.4727 | .0719 | .2491 | -.0027 | -.0005 | .0008 | -6.45 | -.4753 | .0727 | .2526 | -.0091 | -.0005 | .0052 |
| -4.20 | -.2494 | .0473 | .1688 | -.0013 | -.0006 | -.0003 | -4.19 | -.2390 | .0479 | .1708 | -.0082 | -.0002 | .0061 |
| -1.94 | -.0108 | .0397 | .0869 | -.0016 | -.0007 | .0014 | -1.92 | .0044 | .0406 | .0860 | -.0083 | -.0012 | .0073 |
| 0.36 | .2506 | .0479 | .0024 | -.0016 | -.0008 | .0017 | 0.39 | .2704 | .0512 | -.0014 | -.0084 | -.0013 | .0084 |
| 2.61 | .4638 | .0763 | -.0628 | .0001 | -.0005 | .0003 | 2.62 | .4710 | .0788 | -.0639 | -.0068 | -.0009 | .0073 |
| 4.83 | .6258 | .1136 | -.0950 | .0032 | -.0001 | .0003 | 4.84 | .6376 | .1162 | -.0977 | -.0030 | -.0006 | .0048 |
| 6.99 | .7481 | .1566 | -.1060 | .0024 | -.0006 | .0002 | 7.05 | .7900 | .1640 | -.1205 | -.0019 | -.0002 | .0047 |
| 9.12 | .8120 | .2044 | -.0895 | .0036 | -.0001 | -.0029 | 9.13 | .8261 | .2068 | -.0962 | -.0036 | -.0003 | .0024 |
| 11.19 | .8416 | .2506 | -.0767 | -.0012 | -.0008 | -.0008 | 11.25 | .8932 | .2659 | -.0965 | -.0054 | -.0006 | .0032 |
| 13.30 | .9118 | .3087 | -.0849 | -.0018 | -.0005 | -.0022 | 13.32 | .9324 | .3155 | -.0938 | -.0057 | .0000 | .0018 |
| 15.39 | .9905 | .3760 | -.1259 | -.0022 | -.0003 | -.0053 | 15.46 | 1.0089 | .3822 | -.0846 | -.0057 | .0003 | .0063 |
| 17.47 | 1.0480 | .4366 | -.1750 | -.0031 | -.0005 | -.0050 | 17.50 | 1.0893 | .4502 | -.1893 | -.0057 | .0000 | -.0016 |
| 19.48 | 1.0723 | .4901 | -.2242 | -.0045 | .0004 | -.0097 | 19.56 | 1.1419 | .5166 | -.2387 | -.0078 | .0018 | -.0046 |
| | | | M = 0.96 | | | | | | | M = 0.96 | | | |
| -4.18 | -.2261 | .0679 | .1790 | -.0012 | -.0002 | -.0021 | -4.16 | -.2128 | .0639 | .1764 | -.0065 | .0004 | .0032 |
| -1.91 | .0040 | .0609 | .0868 | -.0012 | -.0005 | -.0001 | -1.90 | .0081 | .0563 | .0889 | -.0067 | .0000 | .0047 |
| 0.35 | .2421 | .0722 | -.0183 | -.0019 | -.0013 | .0000 | 0.35 | .2354 | .0692 | -.0088 | -.0065 | -.0008 | .0068 |
| 2.61 | .4744 | .1021 | -.1232 | -.0021 | -.0010 | .0001 | 2.64 | .4908 | .1016 | -.1219 | -.0070 | -.0007 | .0061 |
| 4.83 | .6487 | .1389 | -.1797 | -.0038 | -.0012 | -.0010 | 4.88 | .6900 | .1431 | -.1916 | -.0089 | -.0010 | .0046 |
| 7.07 | .8197 | .1927 | -.2155 | -.0038 | -.0011 | -.0005 | 7.11 | .8510 | .1973 | -.2121 | -.0091 | -.0010 | .0059 |
| | | | | | | | 9.34 | 1.0499 | .2802 | -.3094 | -.0077 | -.0010 | .0022 |

TABLE III.- DATA OBTAINED WITH JET CONTROLS INCLUDING WING-TIP INLETS AND LARGE PLENUM CHAMBER IN WINGS - Continued

*Twelve inboard 0.125-inch-diameter jets open.*

| $\alpha$ | $C_L$ | $C_D$ | $C_m$ | $C_l$ | $C_n$ | $C_Y$ |
|---|---|---|---|---|---|---|
| $M = 0.60$ | | | | | | |
| -6.23 | -.3574 | .0566 | .1582 | -.0123 | -.0018 | .0039 |
| -4.11 | -.1921 | .0438 | .1091 | -.0120 | -.0019 | .0035 |
| -1.98 | -.0161 | .0390 | .0600 | -.0121 | -.0019 | .0072 |
| 0.15 | .1557 | .0412 | .0175 | -.0121 | -.0020 | .0056 |
| 2.28 | .3344 | .0504 | -.0261 | -.0122 | -.0019 | .0060 |
| 4.42 | .5192 | .0762 | -.0696 | -.0123 | -.0018 | .0064 |
| 6.55 | .6807 | .1197 | -.1079 | -.0093 | -.0007 | .0034 |
| 8.64 | .7734 | .1688 | -.1128 | -.0106 | -.0022 | .0056 |
| 10.68 | .8018 | .2156 | -.0848 | -.0086 | -.0013 | .0057 |
| 12.72 | .8331 | .2619 | -.0696 | -.0062 | -.0014 | .0021 |
| 14.74 | .8539 | .3053 | -.0900 | -.0060 | -.0012 | -.0002 |
| 16.78 | .9006 | .3557 | -.1217 | -.0080 | -.0005 | -.0015 |
| 18.84 | .9717 | .4184 | -.1496 | -.0091 | .0008 | -.0040 |
| $M = 0.80$ | | | | | | |
| -6.38 | -.4132 | .0613 | .1832 | -.0128 | -.0014 | .0051 |
| -4.18 | -.2120 | .0435 | .1227 | -.0125 | -.0016 | .0050 |
| -1.95 | -.0062 | .0374 | .0697 | -.0124 | -.0018 | .0072 |
| 0.27 | .1989 | .0422 | .0197 | -.0130 | -.0022 | .0070 |
| 2.51 | .4205 | .0599 | -.0345 | -.0129 | -.0021 | .0066 |
| 4.70 | .6024 | .0934 | -.0830 | -.0119 | -.0019 | .0064 |
| 6.85 | .7227 | .1407 | -.1014 | -.0099 | -.0019 | .0053 |
| 8.94 | .7763 | .1887 | -.0901 | -.0094 | -.0019 | .0047 |
| 11.00 | .8047 | .2323 | -.0749 | -.0076 | -.0015 | .0031 |
| 13.04 | .8360 | .2785 | -.0889 | -.0092 | -.0008 | -.0009 |
| 15.10 | .8860 | .3302 | -.1218 | -.0088 | -.0002 | -.0017 |
| 17.16 | .9425 | .3853 | -.1482 | -.0100 | .0005 | -.0029 |
| 19.25 | 1.0219 | .4551 | -.1918 | -.0103 | .0005 | -.0049 |
| $M = 0.85$ | | | | | | |
| -6.43 | -.4359 | .0651 | .1987 | -.0129 | -.0015 | .0039 |
| -4.18 | -.2192 | .0443 | .1347 | -.0123 | -.0014 | .0032 |
| -1.94 | -.0068 | .0377 | .0764 | -.0127 | -.0020 | .0056 |
| 0.33 | .2231 | .0446 | .0182 | -.0130 | -.0022 | .0057 |
| 2.58 | .4544 | .0668 | -.0429 | -.0131 | -.0019 | .0054 |
| 4.80 | .6373 | .1051 | -.0888 | -.0096 | -.0014 | .0041 |
| 6.93 | .7401 | .1499 | -.1042 | -.0077 | -.0016 | .0032 |
| 9.02 | .7993 | .1971 | -.0991 | -.0046 | -.0009 | .0008 |
| 11.10 | .8312 | .2455 | -.0781 | -.0079 | -.0012 | .0002 |
| 13.14 | .8707 | .2933 | -.0976 | -.0097 | -.0006 | -.0030 |
| 15.22 | .9286 | .3498 | -.1353 | -.0096 | .0004 | -.0057 |
| 17.32 | 1.0121 | .4165 | -.1761 | -.0105 | .0010 | -.0061 |
| 19.36 | 1.0449 | .4701 | -.2049 | -.0089 | .0004 | -.0094 |
| $M = 0.90$ | | | | | | |
| -6.46 | -.4762 | .0754 | .2440 | -.0141 | -.0012 | .0051 |
| -4.21 | -.2530 | .0513 | .1730 | -.0125 | -.0011 | .0037 |
| -1.91 | .0076 | .0427 | .0838 | -.0125 | -.0018 | .0046 |
| 0.39 | .2671 | .0527 | .0006 | -.0133 | -.0021 | .0086 |
| 2.64 | .4853 | .0811 | -.0703 | -.0118 | -.0020 | .0077 |
| 4.85 | .6478 | .1187 | -.1012 | -.0072 | -.0015 | .0055 |
| 7.02 | .7727 | .1647 | -.1188 | -.0074 | -.0019 | .0058 |
| 9.11 | .8112 | .2073 | -.0969 | -.0074 | -.0011 | .0021 |
| 11.19 | .8626 | .2582 | -.0917 | -.0085 | -.0011 | .0023 |
| 13.31 | .9328 | .3179 | -.1081 | -.0090 | -.0005 | -.0013 |
| 15.40 | 1.0119 | .3838 | -.1491 | -.0091 | .0002 | -.0032 |
| 17.50 | 1.0886 | .4536 | -.1983 | -.0093 | .0006 | -.0090 |
| 19.54 | 1.1319 | .5161 | -.2419 | -.0094 | .0020 | -.0075 |
| $M = 0.96$ | | | | | | |
| -4.18 | -.2281 | .0680 | .1834 | -.0111 | .0001 | .0028 |
| -1.91 | .0031 | .0625 | .0882 | -.0112 | -.0004 | .0046 |
| 0.37 | .2542 | .0754 | -.0198 | -.0111 | -.0013 | .0055 |
| 2.63 | .4935 | .1034 | -.1277 | -.0111 | -.0007 | .0042 |
| 4.85 | .6673 | .1408 | -.1824 | -.0160 | -.0014 | .0021 |
| 7.10 | .8601 | .2029 | -.2331 | -.0119 | -.0013 | .0032 |
| 9.47 | 1.0327 | .2793 | -.1530 | -.0083 | -.0010 | .0168 |

*Eighteen inboard 0.125-inch-diameter jets open.*

| $\alpha$ | $C_L$ | $C_D$ | $C_m$ | $C_l$ | $C_n$ | $C_Y$ |
|---|---|---|---|---|---|---|
| $M = 0.60$ | | | | | | |
| -6.23 | -.3593 | .0550 | .1629 | -.0174 | -.0019 | .0065 |
| -4.10 | -.1868 | .0421 | .1129 | -.0172 | -.0022 | .0060 |
| -1.97 | -.0072 | .0363 | .0638 | -.0173 | -.0024 | .0077 |
| 0.16 | .1684 | .0388 | .0185 | -.0172 | -.0025 | .0078 |
| 2.31 | .3543 | .0495 | -.0250 | -.0172 | -.0024 | .0082 |
| 4.44 | .5396 | .0762 | -.0721 | -.0169 | -.0024 | .0102 |
| 6.55 | .6906 | .1190 | -.1086 | -.0135 | -.0013 | .0074 |
| 8.65 | .7871 | .1687 | -.1162 | -.0143 | -.0025 | .0093 |
| 10.71 | .8361 | .2230 | -.0936 | -.0115 | -.0009 | .0071 |
| 12.74 | .8576 | .2665 | -.0810 | -.0080 | -.0010 | .0030 |
| 14.75 | .8781 | .3108 | -.1032 | -.0080 | -.0002 | .0005 |
| 16.79 | .9212 | .3598 | -.1303 | -.0102 | .0007 | -.0002 |
| 18.83 | .9723 | .4149 | -.1555 | -.0114 | .0014 | -.0027 |
| $M = 0.80$ | | | | | | |
| -6.37 | -.4055 | .0587 | .1873 | -.0182 | -.0017 | .0056 |
| -4.15 | -.2017 | .0409 | .1250 | -.0177 | -.0019 | .0067 |
| -1.95 | -.0031 | .0356 | .0720 | -.0176 | -.0022 | .0088 |
| 0.29 | .2091 | .0402 | .0220 | -.0184 | -.0024 | .0101 |
| 2.52 | .4283 | .0590 | -.0341 | -.0183 | -.0023 | .0094 |
| 4.73 | .6223 | .0939 | -.0857 | -.0175 | -.0026 | .0089 |
| 6.85 | .7333 | .1406 | -.1047 | -.0152 | -.0026 | .0104 |
| 8.95 | .7870 | .1903 | -.0970 | -.0135 | -.0020 | .0067 |
| 11.01 | .8225 | .2355 | -.0854 | -.0111 | -.0012 | .0033 |
| 13.05 | .8494 | .2797 | -.0999 | -.0126 | -.0001 | .0006 |
| 15.10 | .8992 | .3317 | -.1361 | -.0127 | .0005 | -.0020 |
| 17.18 | .9669 | .3917 | -.1641 | -.0133 | .0017 | -.0032 |
| 19.26 | 1.0324 | .4571 | -.2046 | -.0135 | .0019 | -.0049 |
| $M = 0.85$ | | | | | | |
| -6.40 | -.4300 | .0619 | .2134 | -.0189 | -.0014 | .0079 |
| -4.15 | -.2138 | .0418 | .1659 | -.0177 | -.0013 | .0111 |
| -1.93 | .0028 | .0399 | .0768 | -.0179 | -.0021 | .0083 |
| 0.33 | .2281 | .0427 | .0203 | -.0185 | -.0024 | .0098 |
| 2.60 | .4755 | .0678 | -.0494 | -.0181 | -.0025 | .0035 |
| 4.82 | .6537 | .1054 | -.0915 | -.0159 | -.0024 | .0088 |
| 6.95 | .7502 | .1497 | -.1067 | -.0125 | -.0020 | .0067 |
| 9.04 | .8097 | .1971 | -.1020 | -.0083 | -.0010 | .0031 |
| 11.11 | .8459 | .2466 | -.0864 | -.0124 | -.0009 | .0032 |
| 13.14 | .8755 | .2908 | -.1096 | -.0127 | -.0001 | -.0006 |
| 15.21 | .9353 | .3478 | -.1475 | -.0133 | .0014 | -.0033 |
| 17.30 | 1.0123 | .4144 | -.1899 | -.0136 | .0017 | -.0040 |
| 19.37 | 1.0653 | .4769 | -.2221 | -.0117 | .0021 | -.0125 |
| $M = 0.90$ | | | | | | |
| -6.47 | -.4893 | .0752 | .2540 | -.0198 | -.0007 | .0026 |
| -4.21 | -.2548 | .0507 | .1750 | -.0175 | -.0006 | .0029 |
| -1.92 | .0014 | .0421 | .0845 | -.0185 | -.0018 | .0047 |
| 0.39 | .2719 | .0510 | -.0030 | -.0186 | -.0023 | .0070 |
| 2.65 | .4964 | .0792 | -.0766 | -.0175 | -.0023 | .0070 |
| 4.86 | .6575 | .1180 | -.1084 | -.0112 | -.0016 | .0047 |
| 7.02 | .7706 | .1609 | -.1228 | -.0155 | -.0023 | .0041 |
| 9.11 | .8204 | .2072 | -.1031 | -.0117 | -.0007 | -.0020 |
| 11.22 | .8975 | .2633 | -.1316 | -.0116 | -.0002 | -.0061 |
| 13.33 | .9531 | .3214 | -.1222 | -.0116 | -.0001 | -.0051 |
| 15.43 | 1.0321 | .3898 | -.1657 | -.0107 | -.0001 | -.0087 |
| 17.44 | 1.0637 | .4412 | -.2148 | -.0106 | .0014 | -.0097 |
| 19.56 | 1.1516 | .5208 | -.2534 | -.0133 | .0018 | -.0088 |
| $M = 0.96$ | | | | | | |
| -4.18 | -.2285 | .0649 | .1850 | -.0172 | .0004 | -.0004 |
| -1.90 | .0112 | .0606 | .0874 | -.0166 | -.0003 | .0024 |
| 0.37 | .2526 | .0707 | -.0206 | -.0163 | -.0010 | .0054 |
| 2.63 | .4904 | .1029 | -.1264 | -.0192 | -.0007 | .0009 |
| 4.87 | .6950 | .1446 | -.1969 | -.0272 | -.0011 | .0005 |
| 7.11 | .8481 | .1953 | -.2081 | -.0165 | -.0013 | .0008 |

TABLE III.- DATA OBTAINED WITH JET CONTROLS INCLUDING WING-TIP INLETS AND LARGE PLENUM CHAMBER IN WINGS - Continued

**Twenty-four 0.125-inch-diameter jets open**

| $\alpha$ | $C_L$ | $C_D$ | $C_m$ | $C_l$ | $C_n$ | $C_Y$ |
|---|---|---|---|---|---|---|
| **M = 0.60** | | | | | | |
| -6.23 | -.3613 | .0557 | .1615 | -.0224 | -.0021 | .0062 |
| -4.10 | -.1845 | .0429 | .1105 | -.0222 | -.0027 | .0096 |
| -1.98 | -.0085 | .0385 | .0613 | -.0225 | -.0026 | .0093 |
| 0.16 | .1711 | .0410 | .0149 | -.0226 | -.0026 | .0133 |
| 2.30 | .3537 | .0516 | -.0286 | -.0223 | -.0026 | .0138 |
| 4.44 | .5430 | .0786 | -.0758 | -.0215 | -.0031 | .0137 |
| 6.56 | .7050 | .1223 | -.1132 | -.0178 | -.0021 | .0109 |
| 8.64 | .7876 | .1703 | -.1215 | -.0178 | -.0028 | .0127 |
| 10.69 | .8193 | .2202 | -.0998 | -.0150 | -.0012 | .0081 |
| 12.73 | .8514 | .2668 | -.0899 | -.0108 | -.0009 | .0038 |
| 14.75 | .8791 | .3112 | -.1121 | -.0106 | .0001 | -.0005 |
| 16.79 | .9253 | .3624 | -.1364 | -.0122 | .0009 | -.0029 |
| 18.83 | .9762 | .4182 | -.1645 | -.0140 | .0018 | -.0037 |
| **M = 0.80** | | | | | | |
| -6.37 | -.4150 | .0620 | .1900 | -.0236 | -.0018 | .0058 |
| -4.17 | -.2060 | .0431 | .1245 | -.0229 | -.0018 | .0066 |
| -1.94 | .0002 | .0370 | .0694 | -.0229 | -.0023 | .0085 |
| 0.28 | .2081 | .0431 | .0181 | -.0237 | -.0025 | .0110 |
| 2.51 | .4255 | .0595 | -.0381 | -.0234 | -.0027 | .0115 |
| 4.72 | .6177 | .0956 | -.0909 | -.0218 | -.0031 | .0122 |
| 6.86 | .7385 | .1428 | -.1093 | -.0196 | -.0033 | .0125 |
| 8.94 | .7801 | .1895 | -.1030 | -.0188 | -.0023 | .0072 |
| 11.00 | .8237 | .2375 | -.0948 | -.0146 | -.0013 | .0035 |
| 13.04 | .8529 | .2820 | -.1087 | -.0155 | -.0007 | .0009 |
| 15.12 | .9164 | .3380 | -.1398 | -.0151 | .0005 | -.0022 |
| 17.17 | .9640 | .3911 | -.1679 | -.0154 | .0010 | -.0038 |
| 19.26 | 1.0358 | .4603 | -.2117 | -.0162 | .0014 | -.0045 |
| **M = 0.85** | | | | | | |
| -6.42 | -.4404 | .0656 | .2042 | -.0242 | -.0015 | .0058 |
| -4.19 | -.2252 | .0456 | .1390 | -.0234 | -.0017 | .0062 |
| -1.93 | .0013 | .0390 | .0749 | -.0234 | -.0024 | .0080 |
| 0.33 | .2315 | .0454 | .0165 | -.0241 | -.0028 | .0106 |
| 2.58 | .4638 | .0688 | -.0533 | -.0239 | -.0030 | .0104 |
| 4.81 | .6535 | .1073 | -.0990 | -.0217 | -.0032 | .0116 |
| 6.92 | .7408 | .1511 | -.1118 | -.0178 | -.0023 | .0072 |
| 9.03 | .8140 | .2012 | -.1099 | -.0134 | -.0018 | .0046 |
| 11.09 | .8444 | .2486 | -.0975 | -.0157 | -.0016 | .0029 |
| 13.14 | .8754 | .2944 | -.1163 | -.0166 | -.0006 | .0011 |
| 15.22 | .9403 | .3511 | -.1540 | -.0163 | .0001 | -.0029 |
| 17.28 | 1.0028 | .4122 | -.1917 | -.0156 | .0005 | -.0058 |
| 19.37 | 1.0626 | .4755 | -.2235 | -.0146 | .0006 | -.0103 |
| **M = 0.90** | | | | | | |
| -6.47 | -.4807 | .0774 | .2511 | -.0249 | -.0012 | .0034 |
| -4.21 | -.2567 | .0524 | .1718 | -.0234 | -.0012 | .0048 |
| -1.91 | .0088 | .0441 | .0812 | -.0234 | -.0022 | .0079 |
| 0.39 | .2780 | .0552 | -.0110 | -.0238 | -.0033 | .0106 |
| 2.65 | .4981 | .0832 | -.0805 | -.0235 | -.0033 | .0100 |
| 4.85 | .6597 | .1213 | -.1150 | -.0164 | -.0022 | .0074 |
| 7.02 | .7770 | .1656 | -.1267 | -.0215 | -.0036 | .0095 |
| 9.11 | .8319 | .2140 | -.1147 | -.0146 | -.0011 | .0001 |
| 11.22 | .8946 | .2658 | -.1148 | -.0149 | -.0015 | .0009 |
| 13.32 | .9546 | .3244 | -.1340 | -.0151 | -.0008 | -.0032 |
| 15.42 | 1.0441 | .3948 | -.1776 | -.0138 | -.0002 | -.0065 |
| 17.47 | 1.0924 | .4533 | -.2210 | -.0114 | -.0012 | -.0093 |
| 19.53 | 1.1334 | .5139 | -.2628 | -.0170 | .0030 | -.0112 |
| **M = 0.96** | | | | | | |
| -4.17 | -.2221 | .0690 | .1849 | -.0219 | .0002 | .0029 |
| -1.91 | .0002 | .0625 | .0879 | -.0215 | -.0010 | .0067 |
| 0.39 | .2781 | .0756 | -.0266 | -.0214 | -.0017 | .0093 |
| 2.63 | .4909 | .1075 | -.1274 | -.0233 | -.0018 | .0073 |
| 4.88 | .6851 | .1456 | -.1847 | -.0273 | -.0019 | .0064 |
| 7.09 | .8604 | .2029 | -.2454 | -.0201 | -.0017 | .0025 |

**Twenty-four 0.140-inch-diameter jets open**

| $\alpha$ | $C_L$ | $C_D$ | $C_m$ | $C_l$ | $C_n$ | $C_Y$ |
|---|---|---|---|---|---|---|
| **M = 0.60** | | | | | | |
| -6.23 | -.3520 | .0552 | .1613 | -.0254 | -.0026 | .0062 |
| -4.10 | -.1896 | .0438 | .1120 | -.0255 | -.0027 | .0077 |
| -1.98 | -.0093 | .0385 | .0609 | -.0256 | -.0031 | .0091 |
| 0.16 | .1704 | .0420 | .0154 | -.0257 | -.0035 | .0113 |
| 2.31 | .3534 | .0521 | -.0273 | -.0255 | -.0036 | .0138 |
| 4.44 | .5468 | .0788 | -.0763 | -.0241 | -.0037 | .0137 |
| 6.56 | .7056 | .1240 | -.1146 | -.0200 | -.0029 | .0126 |
| 8.64 | .7918 | .1720 | -.1239 | -.0200 | -.0032 | .0124 |
| 10.69 | .8273 | .2224 | -.1048 | -.0161 | -.0009 | .0056 |
| 12.73 | .8563 | .2663 | -.0949 | -.0119 | -.0002 | .0013 |
| 14.74 | .8704 | .3083 | -.1179 | -.0112 | .0005 | -.0013 |
| 16.78 | .9236 | .3607 | -.1414 | -.0130 | .0014 | -.0055 |
| 18.84 | .9850 | .4209 | -.1693 | -.0135 | .0020 | -.0062 |
| **M = 0.80** | | | | | | |
| -6.37 | -.4070 | .0611 | .1870 | -.0260 | -.0019 | .0082 |
| -4.17 | -.2148 | .0449 | .1306 | -.0262 | -.0024 | .0086 |
| -1.94 | -.0030 | .0378 | .0710 | -.0260 | -.0029 | .0114 |
| 0.29 | .2129 | .0432 | .0190 | -.0263 | -.0033 | .0124 |
| 2.53 | .4386 | .0621 | -.0417 | -.0258 | -.0041 | .0138 |
| 4.73 | .6237 | .0958 | -.0898 | -.0249 | -.0042 | .0150 |
| 6.87 | .7481 | .1442 | -.1146 | -.0193 | -.0031 | .0106 |
| 8.93 | .7870 | .1910 | -.1066 | -.0202 | -.0028 | .0081 |
| 11.00 | .8260 | .2371 | -.0996 | -.0152 | -.0013 | .0029 |
| 13.05 | .8650 | .2852 | -.1141 | -.0158 | -.0008 | .0017 |
| 15.10 | .9101 | .3363 | -.1485 | -.0157 | .0005 | -.0021 |
| 17.17 | .9786 | .3970 | -.1829 | -.0157 | .0009 | -.0042 |
| 19.25 | 1.0402 | .4600 | -.2185 | -.0154 | .0012 | -.0039 |
| **M = 0.85** | | | | | | |
| -6.41 | -.4306 | .0640 | .2060 | -.0265 | -.0019 | .0086 |
| -4.18 | -.2194 | .0454 | .1401 | -.0258 | -.0023 | .0089 |
| -1.93 | .0051 | .0385 | .0775 | -.0259 | -.0027 | .0122 |
| 0.34 | .2337 | .0454 | .0180 | -.0261 | -.0035 | .0145 |
| 2.60 | .4779 | .0704 | -.0568 | -.0266 | -.0045 | .0163 |
| 4.82 | .6654 | .1080 | -.1002 | -.0249 | -.0045 | .0165 |
| 6.96 | .7672 | .1542 | -.1182 | -.0171 | -.0023 | .0092 |
| 9.01 | .7882 | .2003 | -.1053 | -.0200 | -.0023 | .0075 |
| 11.09 | .8441 | .2465 | -.1012 | -.0158 | -.0013 | .0025 |
| 13.15 | .8842 | .2939 | -.1193 | -.0163 | -.0004 | .0008 |
| 15.22 | .9527 | .3548 | -.1631 | -.0170 | .0009 | -.0026 |
| 17.29 | 1.0169 | .4165 | -.2094 | -.0147 | -.0004 | -.0017 |
| 19.37 | 1.0778 | .4821 | -.2355 | -.0141 | .0001 | -.0068 |
| **M = 0.90** | | | | | | |
| -6.46 | -.4821 | .0774 | .2566 | -.0269 | -.0006 | .0077 |
| -4.20 | -.2469 | .0516 | .1717 | -.0252 | -.0010 | .0073 |
| -1.89 | .0208 | .0430 | .0837 | -.0254 | -.0024 | .0119 |
| 0.42 | .2991 | .0544 | -.0113 | -.0260 | -.0038 | .0167 |
| 2.65 | .5047 | .0837 | -.0838 | -.0265 | -.0042 | .0178 |
| 4.86 | .6677 | .1203 | -.1149 | -.0221 | -.0035 | .0145 |
| 7.04 | .7932 | .1672 | -.1323 | -.0209 | -.0037 | .0137 |
| 9.13 | .8443 | .2140 | -.1201 | -.0133 | -.0010 | .0043 |
| 11.22 | .8952 | .2657 | -.1206 | -.0166 | -.0011 | .0026 |
| 13.31 | .9565 | .3214 | -.1369 | -.0156 | -.0005 | .0013 |
| 15.41 | 1.0358 | .3881 | -.1834 | -.0151 | .0007 | -.0048 |
| 17.44 | 1.0749 | .4433 | -.2295 | -.0121 | -.0006 | -.0046 |
| 19.51 | 1.1288 | .5077 | -.2653 | -.0132 | -.0004 | -.0073 |
| **M = 0.96** | | | | | | |
| -4.16 | -.2174 | .0655 | .1872 | -.0245 | .0001 | .0065 |
| -1.89 | .0172 | .0597 | .0892 | -.0238 | -.0009 | .0105 |
| 0.39 | .2676 | .0724 | -.0245 | -.0240 | -.0019 | .0117 |
| 2.65 | .5003 | .1049 | -.1230 | -.0269 | -.0025 | .0124 |
| 4.90 | .7050 | .1444 | -.1853 | -.0299 | -.0019 | .0110 |
| 7.13 | .8804 | .2044 | -.2355 | -.0211 | -.0015 | .0085 |

TABLE III.- DATA OBTAINED WITH JET CONTROLS INCLUDING WING-TIP INLETS AND LARGE PLENUM CHAMBER IN WINGS - Continued

| Twenty-four 0.156-inch-diameter jets open. | | | | | | |
|---|---|---|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_m$ | $C_l$ | $C_n$ | $C_Y$ |
| **M = 0.60** | | | | | | |
| -6.21 | -.3382 | .0489 | .1536 | -.0272 | -.0027 | .0094 |
| -4.09 | -.1756 | .0421 | .1080 | -.0277 | -.0030 | .0113 |
| -1.97 | .0010 | .0352 | .0597 | -.0276 | -.0034 | .0151 |
| 0.17 | .1842 | .0386 | .0150 | -.0283 | -.0036 | .0174 |
| 2.31 | .3674 | .0503 | -.0295 | -.0275 | -.0035 | .0177 |
| 4.45 | .5604 | .0798 | -.0768 | -.0271 | -.0039 | .0198 |
| 6.57 | .7120 | .1252 | -.1163 | -.0246 | -.0047 | .0203 |
| 8.65 | .8060 | .1697 | -.1243 | -.0222 | -.0033 | .0165 |
| 10.70 | .8448 | .2251 | -.1088 | -.0180 | -.0008 | .0113 |
| 12.73 | .8738 | .2708 | -.1016 | -.0134 | -.0003 | .0067 |
| 14.77 | .9047 | .3181 | -.1265 | -.0126 | .0009 | .0020 |
| 16.81 | .9576 | .3709 | -.1509 | -.0146 | .0024 | -.0022 |
| 18.85 | 1.0089 | .4270 | -.1742 | -.0151 | .0032 | -.0024 |
| **M = 0.80** | | | | | | |
| -6.35 | -.3923 | .0592 | .1802 | -.0281 | -.0020 | .0089 |
| -4.14 | -.1932 | .0411 | .1226 | -.0279 | -.0022 | .0105 |
| -1.93 | .0111 | .0376 | .0675 | -.0279 | -.0027 | .0138 |
| 0.30 | .2266 | .0413 | .0148 | -.0285 | -.0033 | .0148 |
| 2.53 | .4424 | .0611 | -.0420 | -.0278 | -.0041 | .0179 |
| 4.74 | .6413 | .0987 | -.0938 | -.0273 | -.0041 | .0188 |
| 6.88 | .7579 | .1460 | -.1168 | -.0227 | -.0030 | .0145 |
| 8.95 | .8044 | .1949 | -.1112 | -.0226 | -.0028 | .0132 |
| 11.01 | .8404 | .2418 | -.1074 | -.0180 | -.0010 | .0049 |
| 13.05 | .8750 | .2882 | -.1216 | -.0171 | -.0001 | .0009 |
| 15.11 | .9222 | .3396 | -.1560 | -.0176 | .0011 | -.0015 |
| 17.18 | .9907 | .4013 | -.1903 | -.0168 | .0015 | -.0023 |
| 19.25 | 1.0414 | .4606 | -.2270 | -.0157 | .0006 | -.0024 |
| **M = 0.85** | | | | | | |
| -6.40 | -.4194 | .0644 | .1948 | -.0285 | -.0018 | .0105 |
| -4.15 | -.2042 | .0445 | .1356 | -.0281 | -.0022 | .0098 |
| -1.93 | .0114 | .0385 | .0743 | -.0283 | -.0027 | .0144 |
| 0.35 | .2489 | .0465 | .0130 | -.0283 | -.0032 | .0154 |
| 2.62 | .4862 | .0715 | -.0571 | -.0288 | -.0046 | .0176 |
| 4.80 | .6532 | .1052 | -.1008 | -.0283 | -.0046 | .0163 |
| 6.96 | .7731 | .1555 | -.1229 | -.0206 | -.0028 | .0112 |
| 9.01 | .8036 | .2002 | -.1115 | -.0225 | -.0023 | .0081 |
| 11.09 | .8498 | .2490 | -.1109 | -.0186 | -.0009 | .0014 |
| 13.17 | .9031 | .3013 | -.1312 | -.0176 | -.0001 | -.0005 |
| 15.22 | .9564 | .3558 | -.1692 | -.0188 | .0016 | -.0045 |
| 17.28 | 1.0174 | .4158 | -.2182 | -.0153 | -.0006 | -.0029 |
| 19.40 | 1.0965 | .4892 | -.2444 | -.0156 | .0000 | -.0090 |
| **M = 0.90** | | | | | | |
| -6.45 | -.4626 | .0752 | .2398 | -.0287 | -.0012 | .0056 |
| -4.20 | -.2431 | .0502 | .1657 | -.0279 | -.0016 | .0065 |
| -1.90 | .0201 | .0430 | .0789 | -.0282 | -.0025 | .0101 |
| 0.40 | .2872 | .0559 | -.0073 | -.0282 | -.0035 | .0136 |
| 2.66 | .5121 | .0847 | -.0870 | -.0294 | -.0046 | .0151 |
| 4.87 | .6770 | .1217 | -.1221 | -.0261 | -.0039 | .0124 |
| 7.03 | .7922 | .1669 | -.1399 | -.0242 | -.0039 | .0091 |
| 9.07 | .8033 | .2070 | -.1163 | -.0239 | -.0022 | .0043 |
| 11.23 | .9036 | .2712 | -.1321 | -.0198 | -.0001 | -.0022 |
| 13.24 | .9141 | .3137 | -.1499 | -.0180 | .0002 | -.0035 |
| 15.34 | .9941 | .3732 | -.1838 | -.0183 | .0021 | -.0111 |
| 17.45 | 1.0816 | .4491 | -.2410 | -.0158 | .0023 | -.0139 |
| 19.57 | 1.1753 | .5324 | -.2929 | -.0152 | .0009 | -.0150 |
| **M = 0.96** | | | | | | |
| -4.17 | -.2237 | .0644 | .1817 | -.0271 | .0001 | .0057 |
| -1.90 | .0186 | .0587 | .0835 | -.0271 | -.0013 | .0108 |
| 0.38 | .2646 | .0707 | -.0250 | -.0275 | -.0026 | .0115 |
| 2.64 | .4884 | .0995 | -.1162 | -.0331 | -.0035 | .0142 |
| 4.88 | .6941 | .1432 | -.1910 | -.0335 | -.0022 | .0089 |
| 7.08 | .8306 | .1882 | -.1994 | -.0213 | -.0015 | .0052 |

| Twenty-four 0.172-inch-diameter jets open. | | | | | | |
|---|---|---|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_m$ | $C_l$ | $C_n$ | $C_Y$ |
| **M = 0.60** | | | | | | |
| -6.22 | -.3455 | .0554 | .1580 | -.0287 | -.0030 | .0078 |
| -4.10 | -.1792 | .0441 | .1088 | -.0284 | -.0033 | .0114 |
| -1.97 | -.0028 | .0398 | .0605 | -.0286 | -.0034 | .0131 |
| 0.17 | .1875 | .0420 | .0140 | -.0287 | -.0037 | .0133 |
| 2.30 | .3597 | .0528 | -.0296 | -.0286 | -.0035 | .0156 |
| 4.44 | .5491 | .0806 | -.0760 | -.0280 | -.0042 | .0157 |
| 6.56 | .7047 | .1238 | -.1161 | -.0237 | -.0034 | .0144 |
| 8.65 | .8046 | .1751 | -.1245 | -.0237 | -.0037 | .0124 |
| 10.69 | .8303 | .2234 | -.1098 | -.0187 | -.0012 | .0069 |
| 12.72 | .8595 | .2686 | -.1073 | -.0141 | -.0002 | .0018 |
| 14.76 | .8904 | .3154 | -.1322 | -.0135 | .0010 | -.0029 |
| 16.80 | .9400 | .3672 | -.1547 | -.0150 | .0023 | -.0049 |
| 18.83 | .9912 | .4230 | -.1789 | -.0155 | .0033 | -.0072 |
| **M = 0.80** | | | | | | |
| -6.36 | -.3998 | .0609 | .1800 | -.0290 | -.0021 | .0047 |
| -4.15 | -.2006 | .0441 | .1237 | -.0288 | -.0027 | .0064 |
| -1.93 | .0058 | .0389 | .0680 | -.0288 | -.0030 | .0083 |
| 0.30 | .2236 | .0439 | .0172 | -.0295 | -.0036 | .0109 |
| 2.52 | .4371 | .0626 | -.0421 | -.0284 | -.0045 | .0123 |
| 4.74 | .6409 | .0990 | -.0952 | -.0286 | -.0048 | .0131 |
| 6.88 | .7575 | .1471 | -.1195 | -.0234 | -.0038 | .0073 |
| 8.93 | .7872 | .1927 | -.1120 | -.0236 | -.0033 | .0060 |
| 11.00 | .8308 | .2398 | -.1092 | -.0179 | -.0013 | -.0037 |
| 13.03 | .8655 | .2858 | -.1311 | -.0181 | -.0002 | -.0073 |
| 15.10 | .9194 | .3388 | -.1592 | -.0181 | .0015 | -.0100 |
| 17.17 | .9793 | .3972 | -.1934 | -.0167 | .0015 | -.0082 |
| 19.25 | 1.0452 | .4620 | -.2308 | -.0165 | .0014 | -.0109 |
| **M = 0.85** | | | | | | |
| -6.41 | -.4266 | .0653 | .1997 | -.0293 | -.0020 | .0041 |
| -4.19 | -.2249 | .0462 | .1384 | -.0289 | -.0023 | .0061 |
| -1.94 | .0044 | .0388 | .0742 | -.0284 | -.0030 | .0092 |
| 0.33 | .2371 | .0461 | .0157 | -.0293 | -.0037 | .0105 |
| 2.62 | .4901 | .0727 | -.0603 | -.0303 | -.0047 | .0147 |
| 4.83 | .6707 | .1102 | -.1037 | -.0287 | -.0052 | .0122 |
| 6.94 | .7641 | .1540 | -.1225 | -.0216 | -.0046 | .0059 |
| 9.00 | .7945 | .1986 | -.1117 | -.0235 | -.0029 | .0054 |
| 11.08 | .8409 | .2469 | -.1196 | -.0188 | -.0007 | -.0044 |
| 13.14 | .8875 | .2974 | -.1401 | -.0187 | .0004 | -.0081 |
| 15.22 | .9555 | .3564 | -.1751 | -.0195 | .0028 | -.0115 |
| 17.25 | 1.0013 | .4122 | -.2241 | -.0161 | .0006 | -.0100 |
| 19.35 | 1.0694 | .4788 | -.2503 | -.0156 | .0003 | -.0113 |
| **M = 0.90** | | | | | | |
| -6.46 | -.4761 | .0775 | .2506 | -.0294 | -.0012 | .0021 |
| -4.21 | -.2473 | .0532 | .1657 | -.0282 | -.0020 | .0028 |
| -1.90 | .0201 | .0446 | .0788 | -.0286 | -.0031 | .0076 |
| 0.40 | .2826 | .0542 | -.0046 | -.0289 | -.0040 | .0091 |
| 2.66 | .5095 | .0845 | -.0860 | -.0303 | -.0049 | .0116 |
| 4.87 | .6786 | .1218 | -.1223 | -.0276 | -.0048 | .0088 |
| 7.02 | .7877 | .1662 | -.1383 | -.0247 | -.0043 | .0056 |
| 9.10 | .8323 | .2130 | -.1263 | -.0180 | -.0015 | -.0014 |
| 11.19 | .8826 | .2650 | -.1294 | -.0207 | .0002 | -.0068 |
| 13.27 | .9443 | .3203 | -.1566 | -.0193 | .0011 | -.0107 |
| 15.36 | 1.0131 | .3822 | -.1950 | -.0195 | .0031 | -.0146 |
| 17.45 | 1.0905 | .4527 | -.2495 | -.0179 | .0033 | -.0195 |
| 19.50 | 1.1357 | .5154 | -.2875 | -.0159 | .0016 | -.0195 |
| **M = 0.96** | | | | | | |
| -4.17 | -.2239 | .0676 | .1843 | -.0268 | .0001 | -.0018 |
| -1.90 | .0080 | .0606 | .0886 | -.0275 | -.0014 | .0035 |
| 0.37 | .2626 | .0738 | -.0276 | -.0273 | -.0027 | .0055 |
| 2.63 | .4889 | .1058 | -.1238 | -.0305 | -.0029 | .0065 |
| 4.90 | .7131 | .1498 | -.2067 | -.0353 | -.0024 | .0019 |
| 7.08 | .8397 | .1940 | -.2256 | -.0242 | -.0017 | -.0019 |

TABLE III.- DATA OBTAINED WITH JET CONTROLS INCLUDING WING-TIP

INLETS AND LARGE PLENUM CHAMBER IN WINGS - Concluded

| Eighteen outboard 0.172-inch-diameter jets open. | | | | | | |
|---|---|---|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_m$ | $C_l$ | $C_n$ | $C_Y$ |
| | | | M = 0.60 | | | |
| -6.23 | -.3521 | .0553 | .1581 | -.0238 | -.0015 | .0059 |
| -4.10 | -.1825 | .0424 | .1097 | -.0239 | -.0020 | .0056 |
| -1.98 | -.0093 | .0381 | .0594 | -.0244 | -.0020 | .0071 |
| 0.16 | .1780 | .0405 | .0147 | -.0245 | -.0022 | .0114 |
| 2.30 | .3649 | .0515 | -.0300 | -.0244 | -.0025 | .0118 |
| 4.44 | .5481 | .0785 | -.0771 | -.0229 | -.0033 | .0137 |
| 6.55 | .7069 | .1247 | -.1186 | -.0206 | -.0034 | .0121 |
| 8.65 | .8077 | .1747 | -.1257 | -.0180 | -.0029 | .0104 |
| 10.70 | .8433 | .2234 | -.1048 | -.0152 | -.0003 | .0058 |
| 12.73 | .8650 | .2674 | -.0949 | -.0114 | -.0001 | -.0006 |
| 14.76 | .8965 | .3143 | -.1218 | -.0108 | .0006 | -.0035 |
| 16.80 | .9428 | .3670 | -.1498 | -.0117 | .0017 | -.0064 |
| 18.83 | .9948 | .4226 | -.1739 | -.0117 | .0019 | -.0067 |
| | | | M = 0.80 | | | |
| -6.36 | -.3992 | .0621 | .1841 | -.0244 | -.0010 | .0040 |
| -4.15 | -.1995 | .0419 | .1247 | -.0231 | -.0014 | .0067 |
| -1.93 | .0071 | .0364 | .0702 | -.0234 | -.0016 | .0088 |
| 0.28 | .2132 | .0414 | .0180 | -.0242 | -.0021 | .0111 |
| 2.53 | .4388 | .0610 | -.0414 | -.0237 | -.0032 | .0126 |
| 4.74 | .6385 | .0964 | -.0945 | -.0234 | -.0038 | .0146 |
| 6.88 | .7552 | .1440 | -.1156 | -.0184 | -.0026 | .0106 |
| 8.95 | .7990 | .1913 | -.1062 | -.0179 | -.0013 | .0058 |
| 11.01 | .8374 | .2395 | -.1025 | -.0140 | -.0001 | .0015 |
| 13.05 | .8746 | .2859 | -.1182 | -.0146 | -.0002 | -.0014 |
| 15.11 | .9218 | .3377 | -.1527 | -.0153 | .0011 | -.0038 |
| 17.16 | .9671 | .3915 | -.1902 | -.0156 | .0022 | -.0065 |
| 19.23 | 1.0335 | .4554 | -.2308 | -.0153 | .0028 | -.0081 |
| | | | M = 0.85 | | | |
| -6.40 | -.4192 | .0614 | .1977 | -.0244 | -.0007 | .0040 |
| -4.19 | -.2219 | .0434 | .1405 | -.0235 | -.0008 | .0040 |
| -1.92 | .0123 | .0366 | .0751 | -.0234 | -.0015 | .0096 |
| 0.34 | .2432 | .0439 | .0149 | -.0238 | -.0019 | .0106 |
| 2.62 | .4874 | .0701 | -.0565 | -.0247 | -.0033 | .0128 |
| 4.82 | .6665 | .1058 | -.1029 | -.0229 | -.0039 | .0124 |
| 6.96 | .7731 | .1521 | -.1190 | -.0154 | -.0016 | .0056 |
| 9.03 | .8077 | .1990 | -.1066 | -.0168 | -.0007 | .0014 |
| 11.11 | .8667 | .2518 | -.1093 | -.0154 | -.0002 | -.0007 |
| 13.15 | .8892 | .2944 | -.1240 | -.0162 | .0005 | -.0034 |
| 15.22 | .9660 | .3600 | -.1778 | -.0170 | .0025 | -.0080 |
| 17.25 | .9986 | .4078 | -.2184 | -.0155 | .0018 | -.0054 |
| 19.37 | 1.0829 | .4830 | -.2533 | -.0152 | .0026 | -.0062 |
| | | | M = 0.90 | | | |
| -6.44 | -.4695 | .0744 | .2490 | -.0246 | .0002 | .0022 |
| -4.20 | -.2424 | .0481 | .1640 | -.0230 | .0000 | .0040 |
| -1.89 | .0212 | .0399 | .0815 | -.0231 | -.0013 | .0081 |
| 0.39 | .2825 | .0528 | -.0065 | -.0237 | -.0026 | .0126 |
| 2.66 | .5142 | .0818 | -.0851 | -.0238 | -.0028 | .0120 |
| 4.87 | .6792 | .1199 | -.1231 | -.0215 | -.0026 | .0089 |
| 7.04 | .8004 | .1649 | -.1380 | -.0218 | -.0032 | .0083 |
| 9.10 | .8179 | .2074 | -.1119 | -.0200 | -.0010 | .0028 |
| 11.22 | .8955 | .2663 | -.1235 | -.0167 | .0007 | -.0023 |
| 13.28 | .9367 | .3137 | -.1417 | -.0171 | .0011 | -.0041 |
| 15.36 | 1.0166 | .3805 | -.1920 | -.0164 | .0023 | -.0083 |
| 17.43 | 1.0863 | .4486 | -.2600 | -.0129 | .0005 | -.0096 |
| 19.63 | 1.1324 | .5131 | -.1452 | -.0152 | .0019 | .0078 |
| | | | M = 0.96 | | | |
| -4.16 | -.2194 | .0626 | .1824 | -.0234 | .0005 | .0037 |
| -1.89 | .0194 | .0557 | .0842 | -.0232 | -.0008 | .0076 |
| 0.39 | .2718 | .0694 | -.0235 | -.0240 | -.0022 | .0108 |
| 2.64 | .4906 | .0998 | -.1154 | -.0275 | -.0026 | .0122 |
| 4.89 | .7063 | .1430 | -.1930 | -.0286 | -.0015 | .0056 |
| 7.10 | .8529 | .1899 | -.2198 | -.0186 | -.0009 | .0027 |

| Twelve outboard 0.172-inch-diameter jets open. | | | | | | |
|---|---|---|---|---|---|---|
| $\alpha$ | $C_L$ | $C_D$ | $C_m$ | $C_l$ | $C_n$ | $C_Y$ |
| | | | M = 0.60 | | | |
| -6.23 | -.3526 | .0549 | .1583 | -.0178 | -.0012 | .0040 |
| -4.10 | -.1798 | .0417 | .1074 | -.0175 | -.0012 | .0054 |
| -1.97 | -.0039 | .0362 | .0601 | -.0178 | -.0015 | .0073 |
| 0.16 | .1755 | .0400 | .0137 | -.0183 | -.0017 | .0114 |
| 2.30 | .3580 | .0496 | -.0298 | -.0181 | -.0018 | .0098 |
| 4.45 | .5508 | .0777 | -.0751 | -.0175 | -.0024 | .0140 |
| 6.57 | .7087 | .1239 | -.1146 | -.0156 | -.0027 | .0126 |
| 8.66 | .8128 | .1743 | -.1226 | -.0135 | -.0026 | .0128 |
| 10.72 | .8517 | .2178 | -.0964 | -.0119 | .0004 | .0030 |
| 12.74 | .8715 | .2687 | -.0822 | -.0093 | .0003 | .0011 |
| 14.77 | .8892 | .3127 | -.1043 | -.0089 | -.0002 | .0025 |
| 16.81 | .9527 | .3715 | -.1367 | -.0089 | .0005 | -.0007 |
| 18.85 | .9942 | .4235 | -.1608 | -.0091 | .0003 | -.0033 |
| | | | M = 0.80 | | | |
| -6.34 | -.3844 | .0567 | .1806 | -.0182 | -.0004 | .0025 |
| -4.14 | -.1902 | .0405 | .1233 | -.0174 | -.0006 | .0041 |
| -1.93 | .0112 | .0356 | .0677 | -.0176 | -.0012 | .0072 |
| 0.30 | .2214 | .0415 | .0158 | -.0180 | -.0015 | .0082 |
| 2.53 | .4387 | .0611 | -.0403 | -.0179 | -.0022 | .0114 |
| 4.74 | .6303 | .0950 | -.0901 | -.0175 | -.0029 | .0111 |
| 6.89 | .7556 | .1441 | -.1088 | -.0134 | -.0015 | .0075 |
| 8.96 | .7991 | .1917 | -.0952 | -.0135 | -.0012 | .0058 |
| 11.01 | .8231 | .2365 | -.0873 | -.0109 | -.0008 | .0045 |
| 13.06 | .8623 | .2829 | -.0968 | -.0116 | -.0010 | .0038 |
| 15.11 | .9078 | .3343 | -.1329 | -.0113 | -.0008 | .0024 |
| 17.17 | .9665 | .3917 | -.1704 | -.0125 | .0003 | -.0015 |
| 19.22 | 1.0102 | .4471 | -.2078 | -.0126 | -.0001 | -.0018 |
| | | | M = 0.85 | | | |
| -6.40 | -.4249 | .0636 | .2007 | -.0186 | -.0004 | .0019 |
| -4.17 | -.2058 | .0432 | .1368 | -.0179 | -.0004 | .0025 |
| -1.92 | .0139 | .0373 | .0728 | -.0177 | -.0010 | .0043 |
| 0.35 | .2391 | .0446 | .0174 | -.0185 | -.0014 | .0084 |
| 2.59 | .4758 | .0687 | -.0525 | -.0189 | -.0028 | .0106 |
| 4.83 | .6648 | .1075 | -.0941 | -.0172 | -.0029 | .0111 |
| 6.96 | .7683 | .1526 | -.1122 | -.0106 | -.0010 | .0038 |
| 9.02 | .7982 | .1995 | -.0982 | -.0139 | -.0011 | .0048 |
| 11.11 | .8460 | .2477 | -.0952 | -.0129 | -.0011 | .0033 |
| 13.18 | .8965 | .2997 | -.1097 | -.0131 | -.0010 | .0020 |
| 15.23 | .9462 | .3527 | -.1475 | -.0133 | -.0004 | .0004 |
| 17.25 | .9850 | .4047 | -.2020 | -.0084 | -.0041 | .0021 |
| 19.35 | 1.0531 | .4730 | -.2282 | -.0093 | -.0021 | -.0052 |
| | | | M = 0.90 | | | |
| -6.44 | -.4686 | .0754 | .2541 | -.0198 | .0004 | .0006 |
| -4.20 | -.2439 | .0512 | .1669 | -.0174 | .0000 | .0020 |
| -1.91 | .0121 | .0425 | .0819 | -.0178 | -.0009 | .0058 |
| 0.40 | .2783 | .0544 | -.0030 | -.0185 | -.0021 | .0083 |
| 2.66 | .5004 | .0827 | -.0797 | -.0194 | -.0028 | .0089 |
| 4.87 | .6757 | .1195 | -.1145 | -.0152 | -.0021 | .0064 |
| 7.05 | .8013 | .1673 | -.1315 | -.0178 | -.0028 | .0068 |
| 9.09 | .8084 | .2097 | -.1038 | -.0160 | -.0012 | .0013 |
| 11.20 | .8726 | .2609 | -.1087 | -.0125 | -.0012 | .0014 |
| 13.32 | .9538 | .3224 | -.1305 | -.0121 | -.0005 | -.0015 |
| 15.38 | 1.0144 | .3824 | -.1739 | -.0100 | -.0015 | .0005 |
| 17.40 | 1.0470 | .4356 | -.2307 | -.0060 | -.0054 | .0013 |
| 19.48 | 1.1053 | .5026 | -.2696 | -.0113 | -.0006 | -.0059 |
| | | | M = 0.96 | | | |
| -4.17 | -.2207 | .0643 | .1798 | -.0183 | .0008 | .0013 |
| -1.89 | .0152 | .0619 | .0873 | -.0171 | -.0004 | .0057 |
| 0.37 | .2521 | .0706 | -.0158 | -.0183 | -.0016 | .0093 |
| 2.61 | .4636 | .0998 | -.1038 | -.0223 | -.0025 | .0100 |
| 4.89 | .6946 | .1449 | -.1834 | -.0221 | -.0009 | .0057 |
| 7.11 | .8597 | .1953 | -.2205 | -.0134 | -.0007 | .0005 |

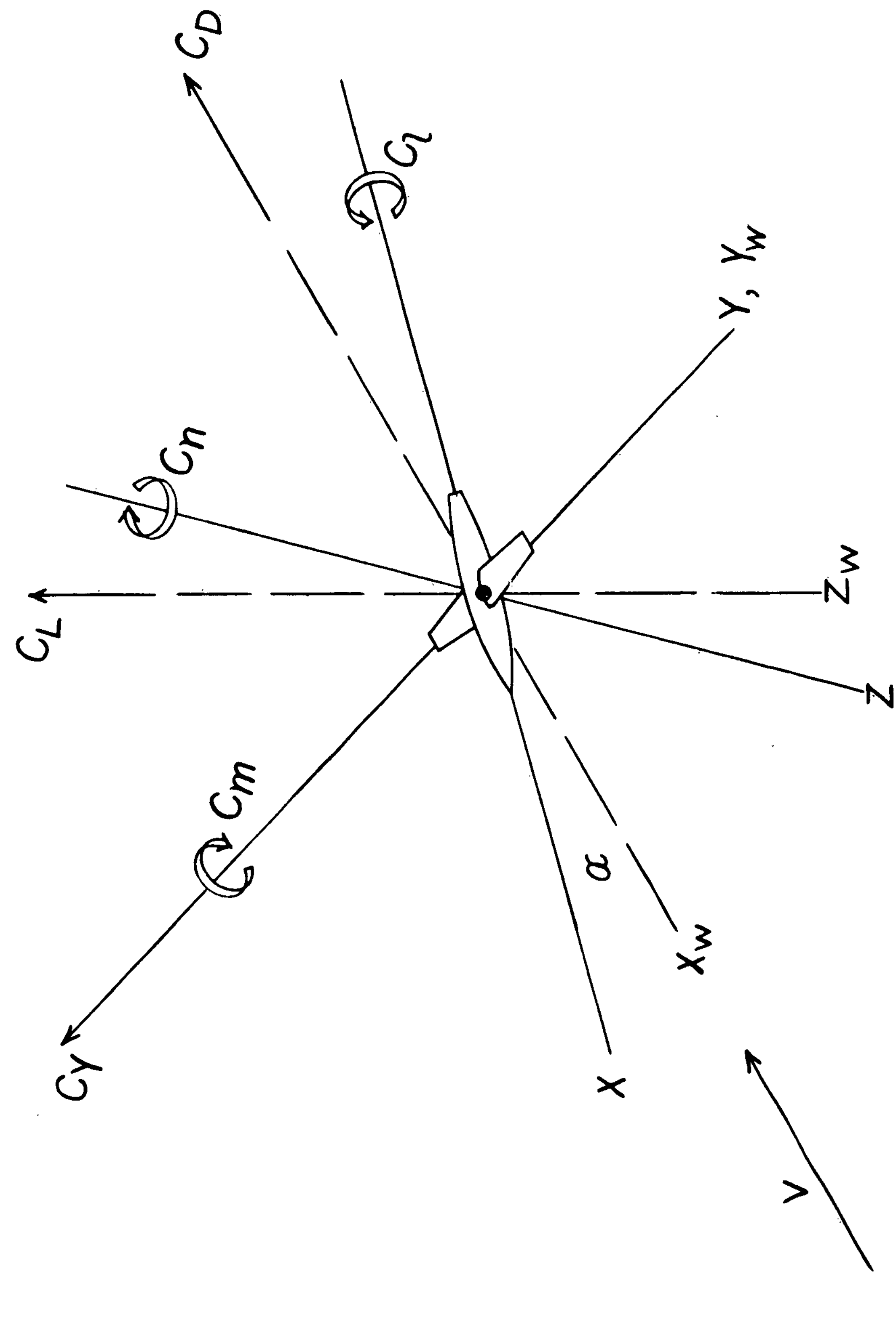



Figure 1.- Systems of axes used. Positive directions of forces and moments are indicated by arrows.

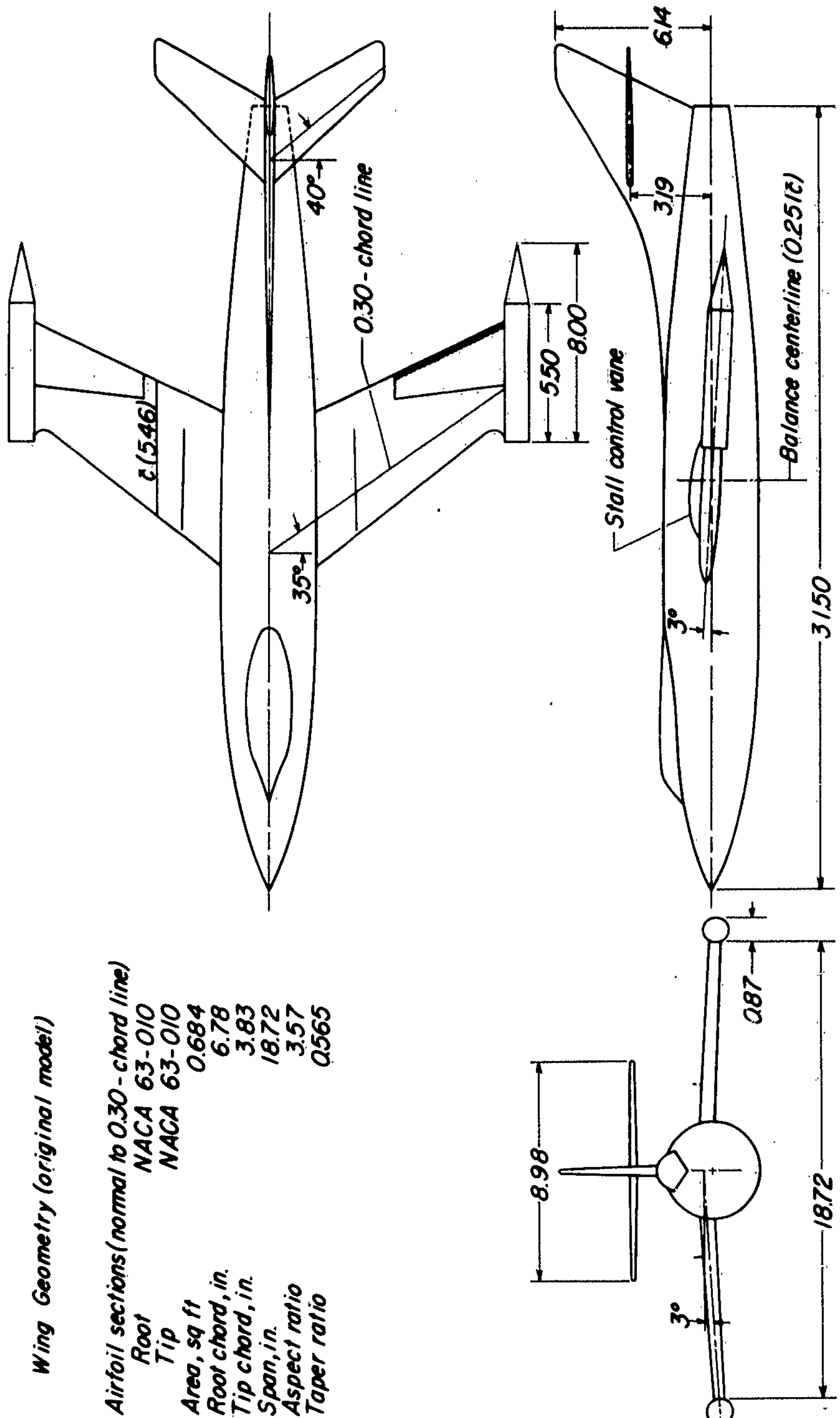
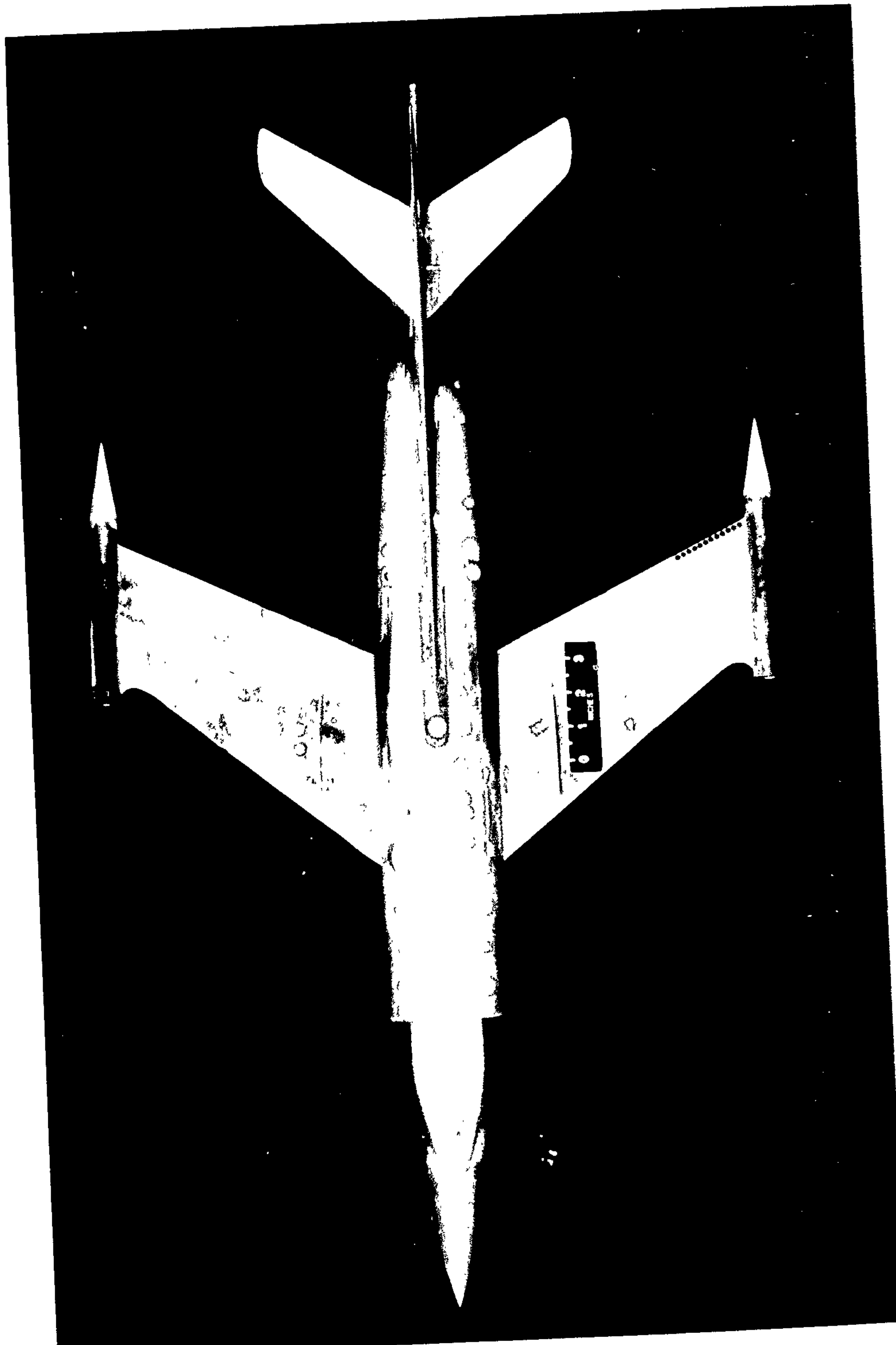
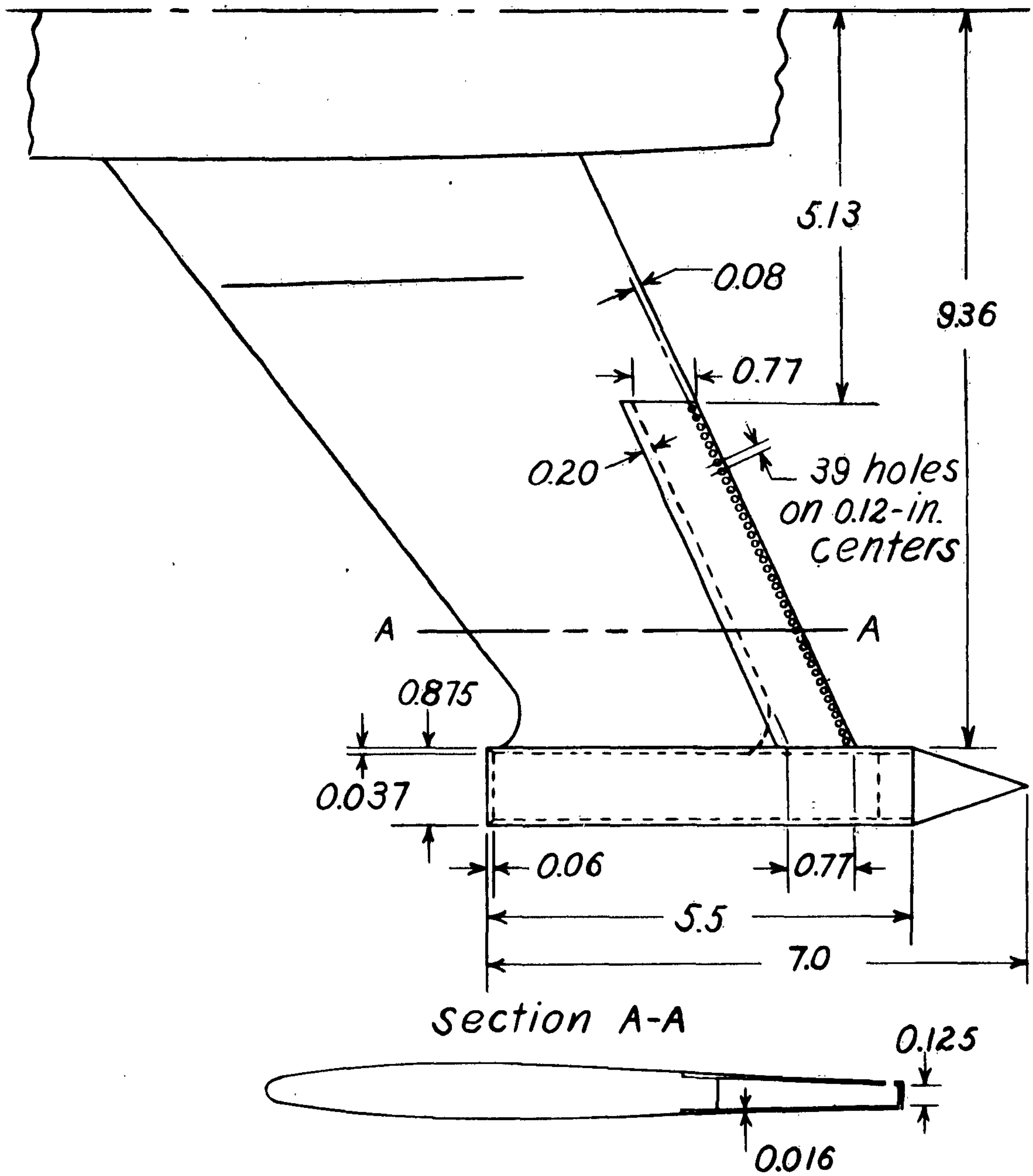



Figure 2.- Three-view drawing of model with large plenum chamber in wing. All dimensions in inches unless noted.



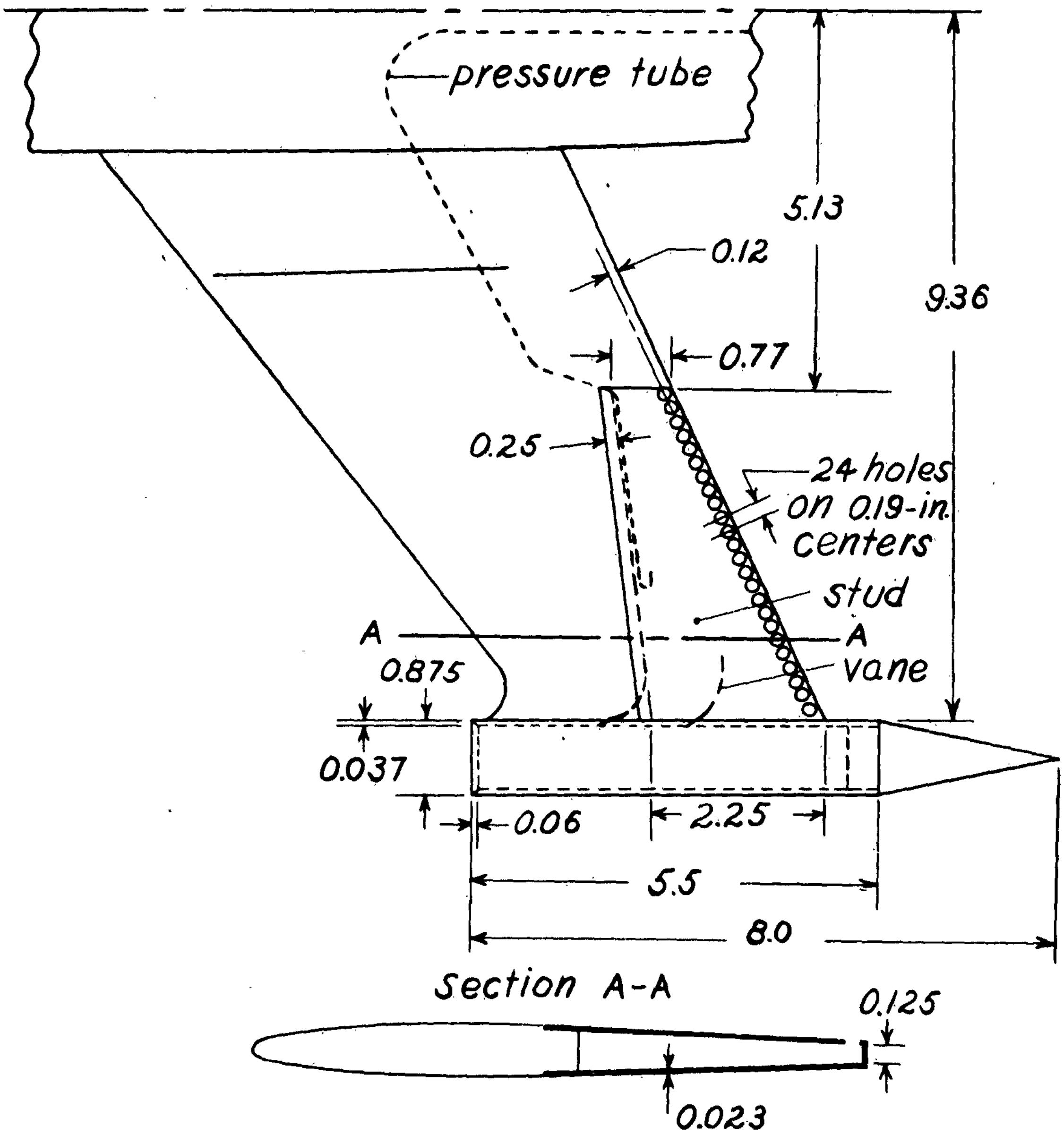
L-89567

Figure 3.- Photograph of model with 0.172-inch-diameter jet holes and large plenum chamber.




(a) Small plenum chamber.

Figure 4.- Details of jet controls. All dimensions are in inches.




(b) Large plenum chamber.

Figure 4.- Concluded.

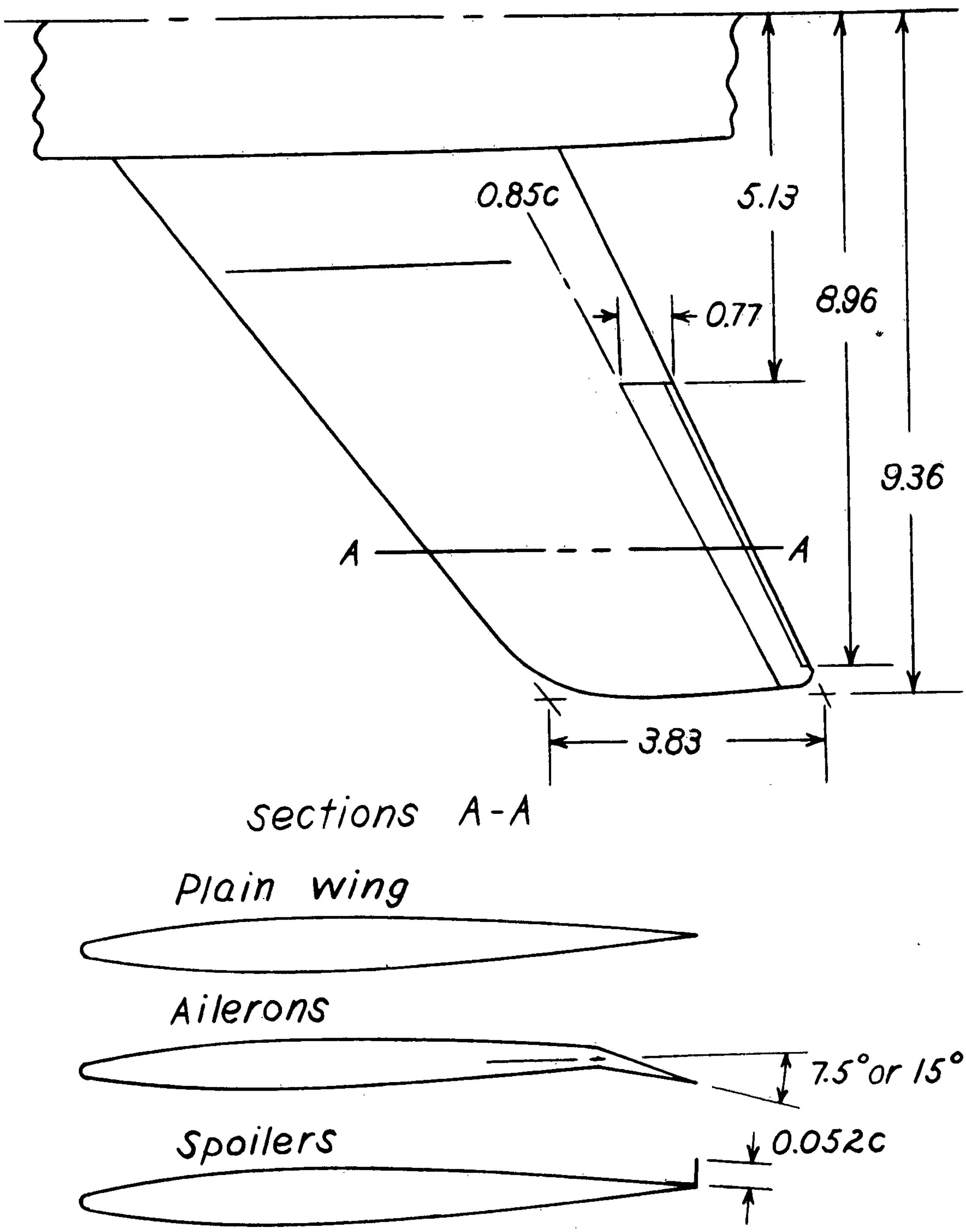



Figure 5.- Aileron and spoiler details. All dimensions in inches.

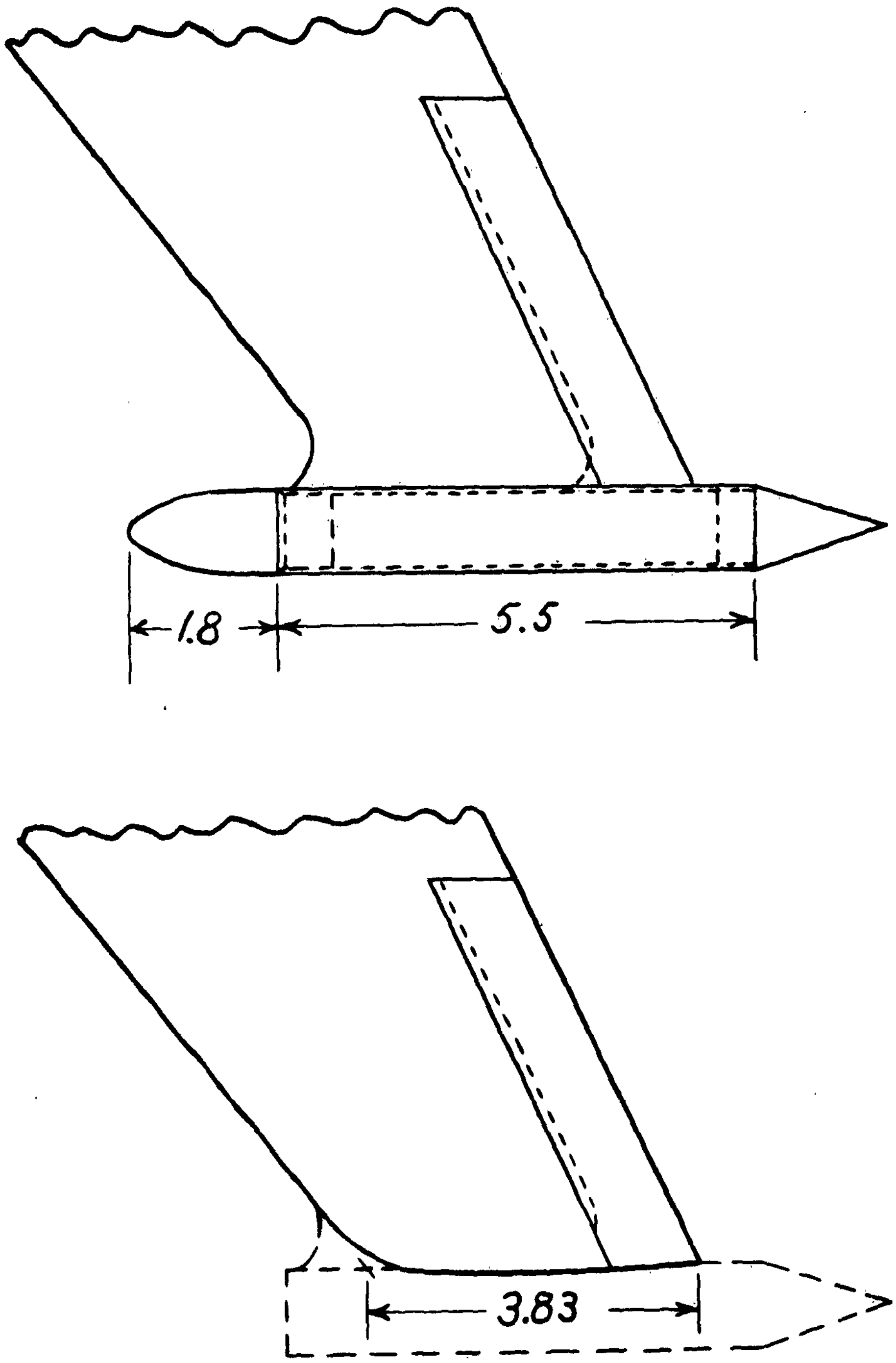
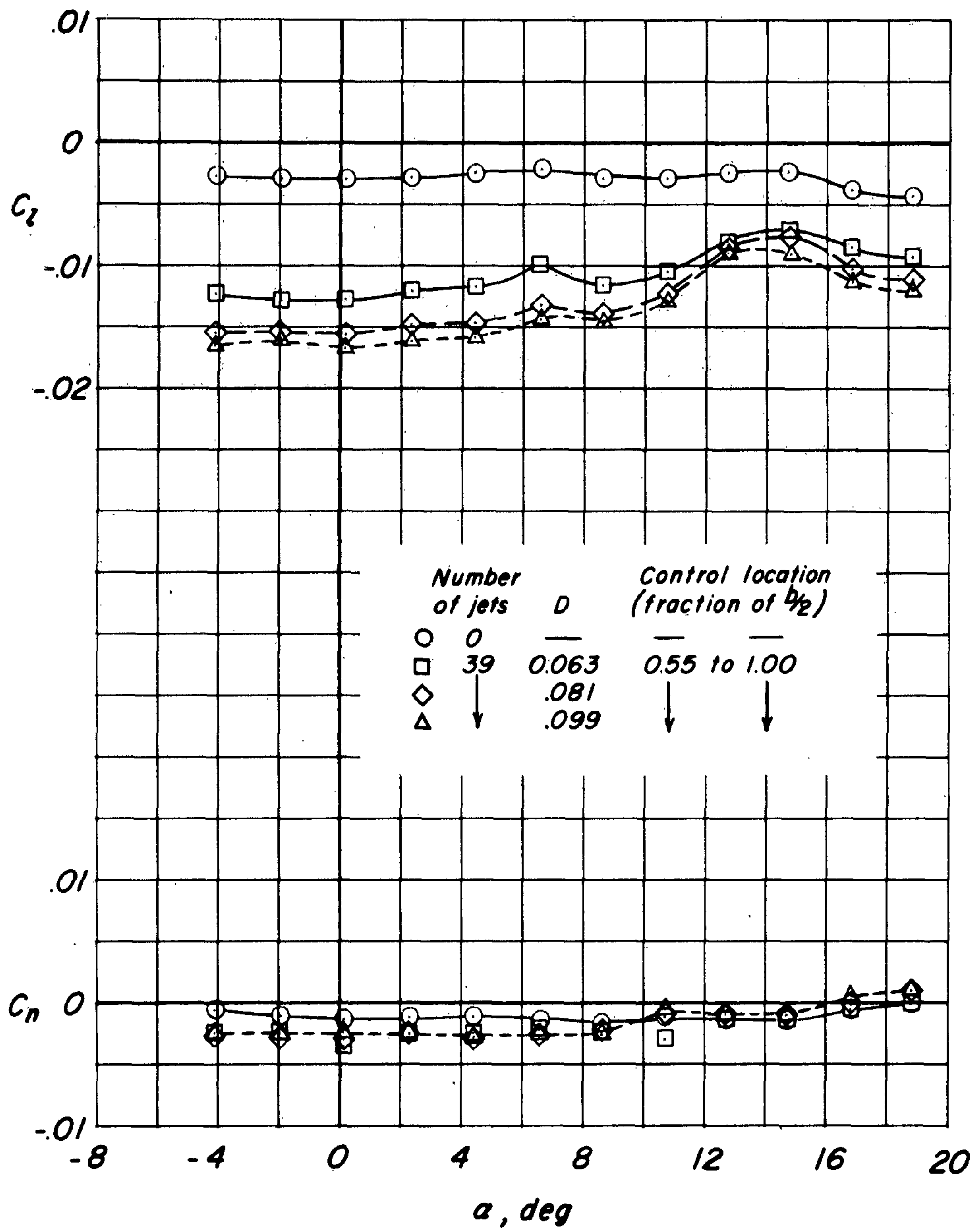
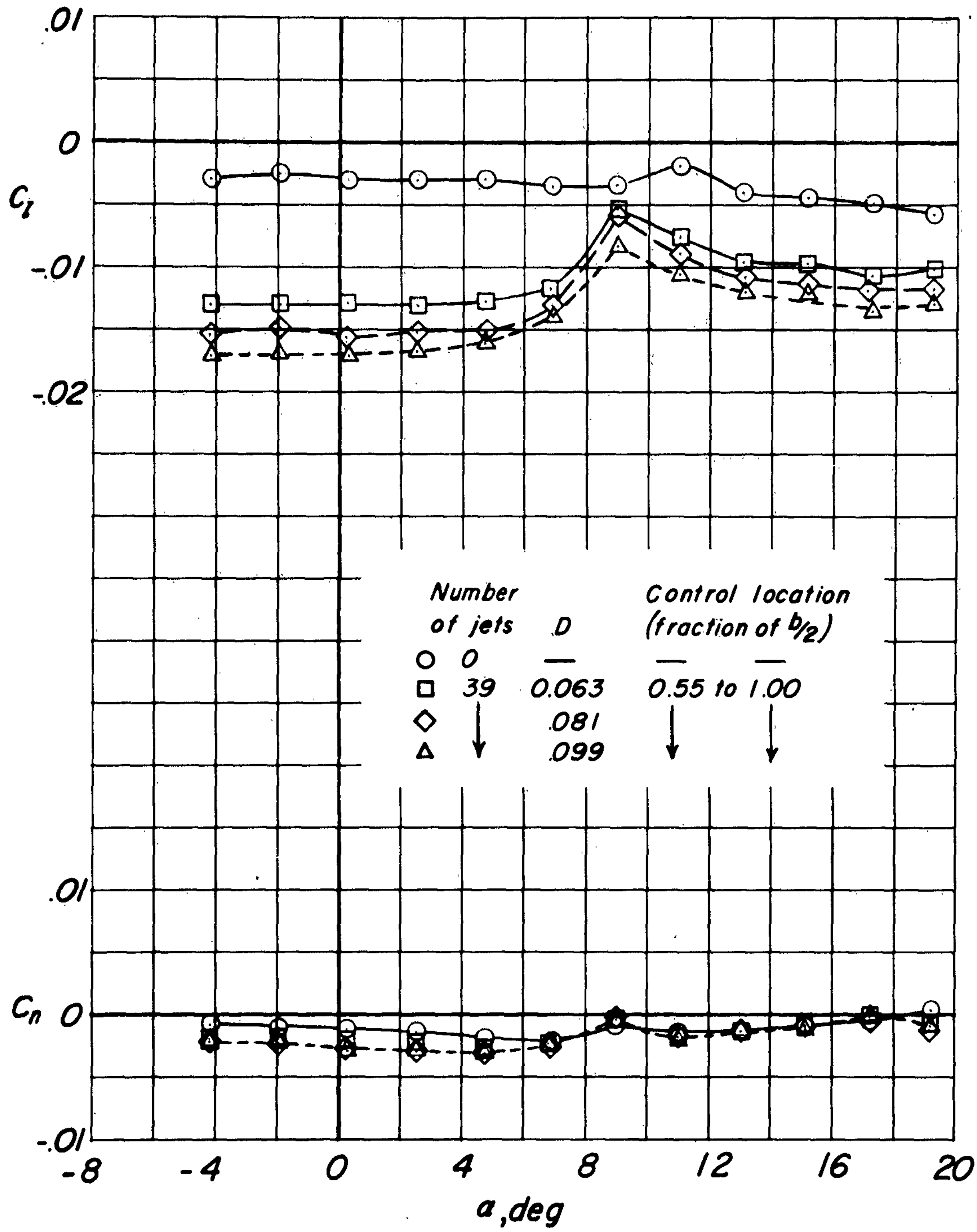



Figure 6.- Drawings of inlet plug, and of faired wing tip with the small plenum chamber attached and wing-tip inlets removed. All dimensions in inches.



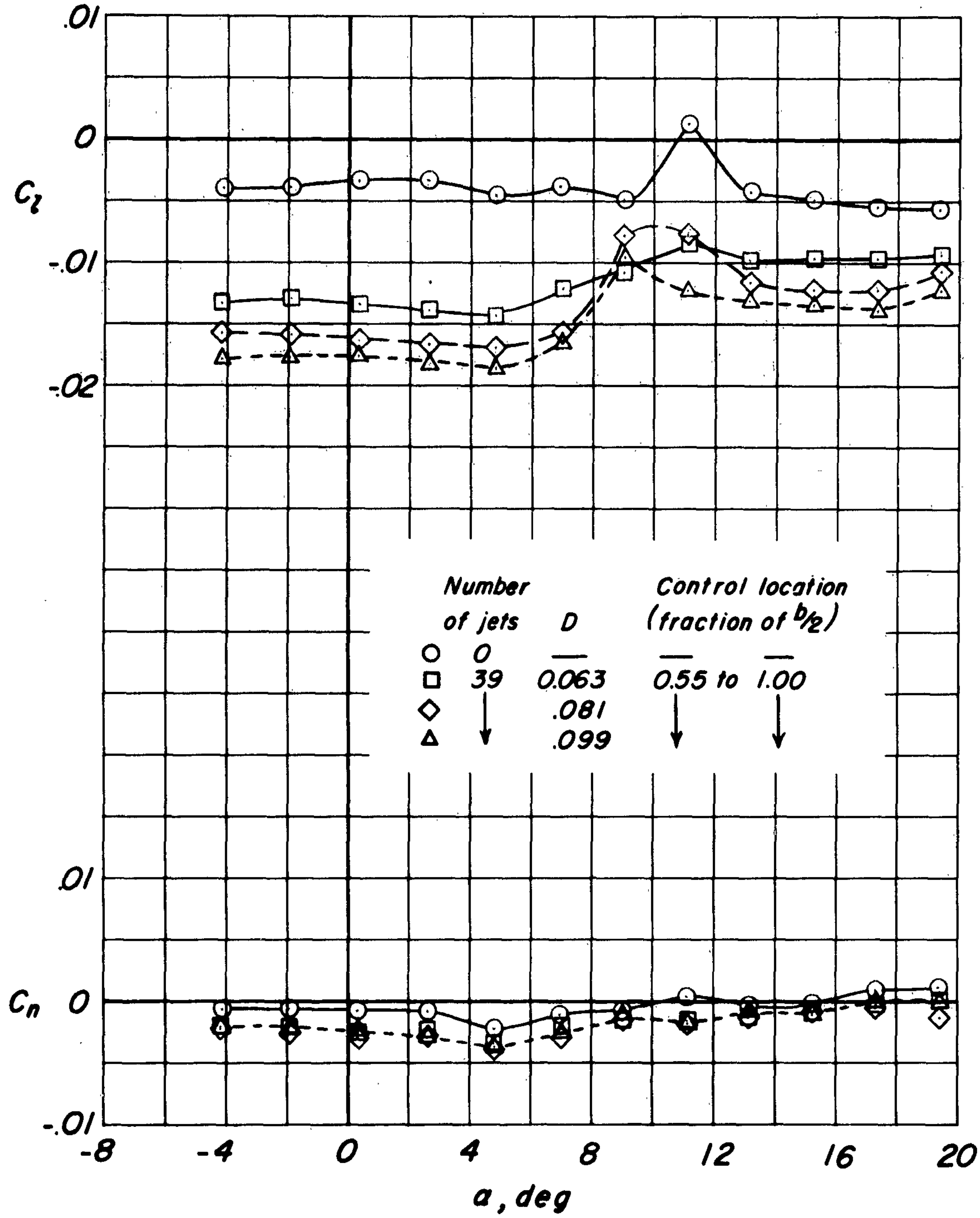

(a) M = 0.60.

Figure 7.- Variation of rolling- and yawing-moment coefficients with angle of attack for wing with control-jet holes of three diameters in the small plenum chamber.



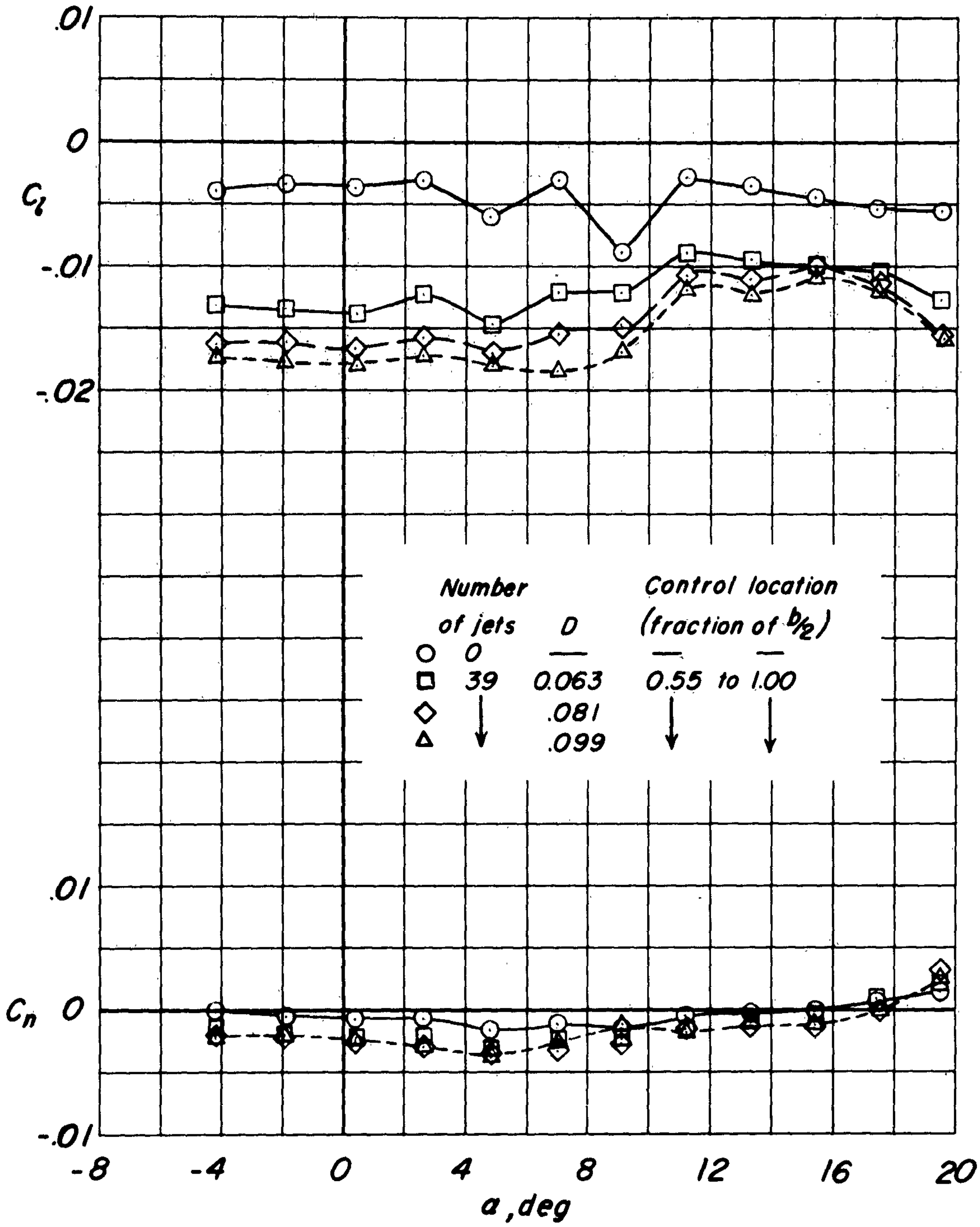

(b) M = 0.80.

Figure 7.- Continued.



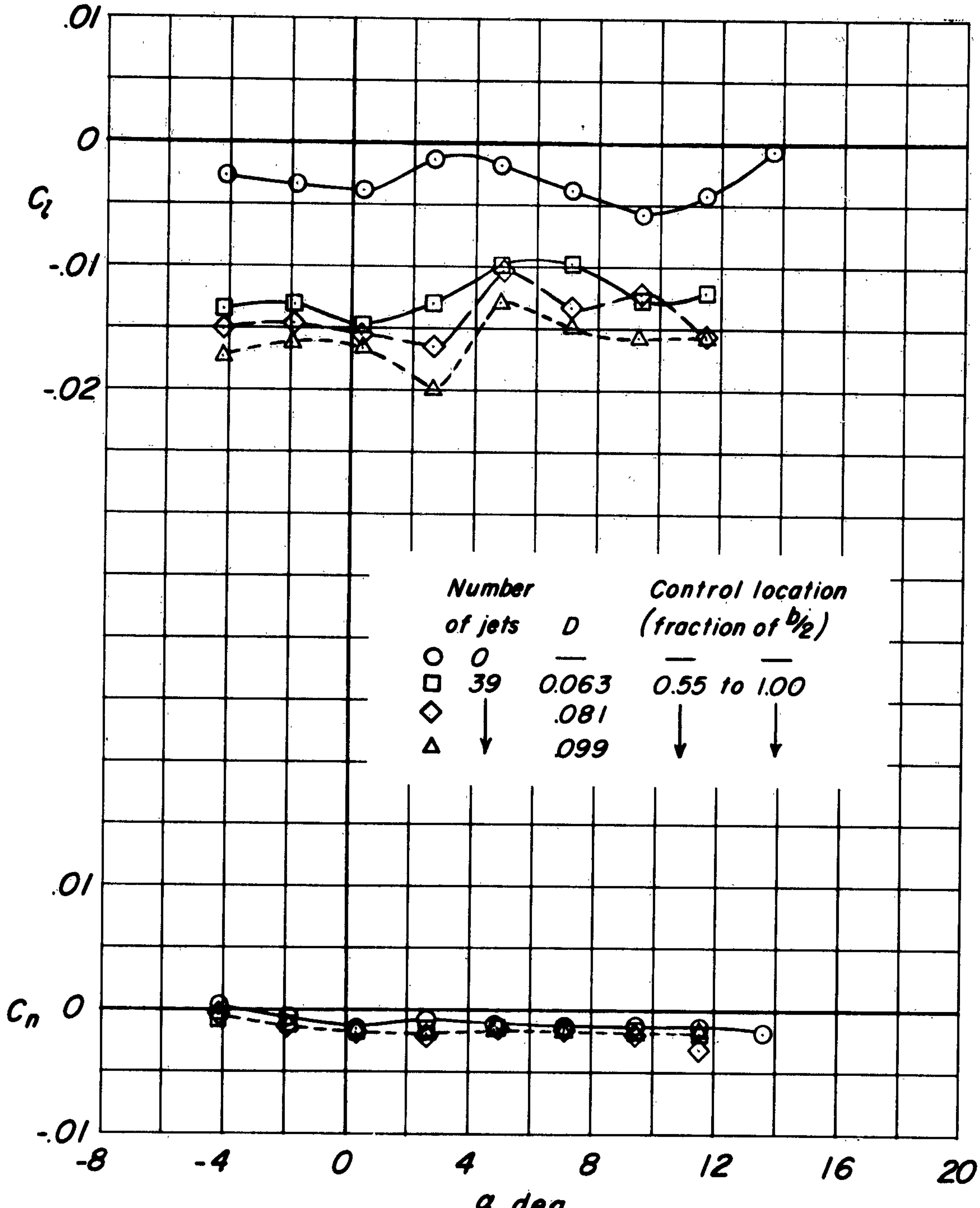

(c) M = 0.85.

Figure 7.- Continued.



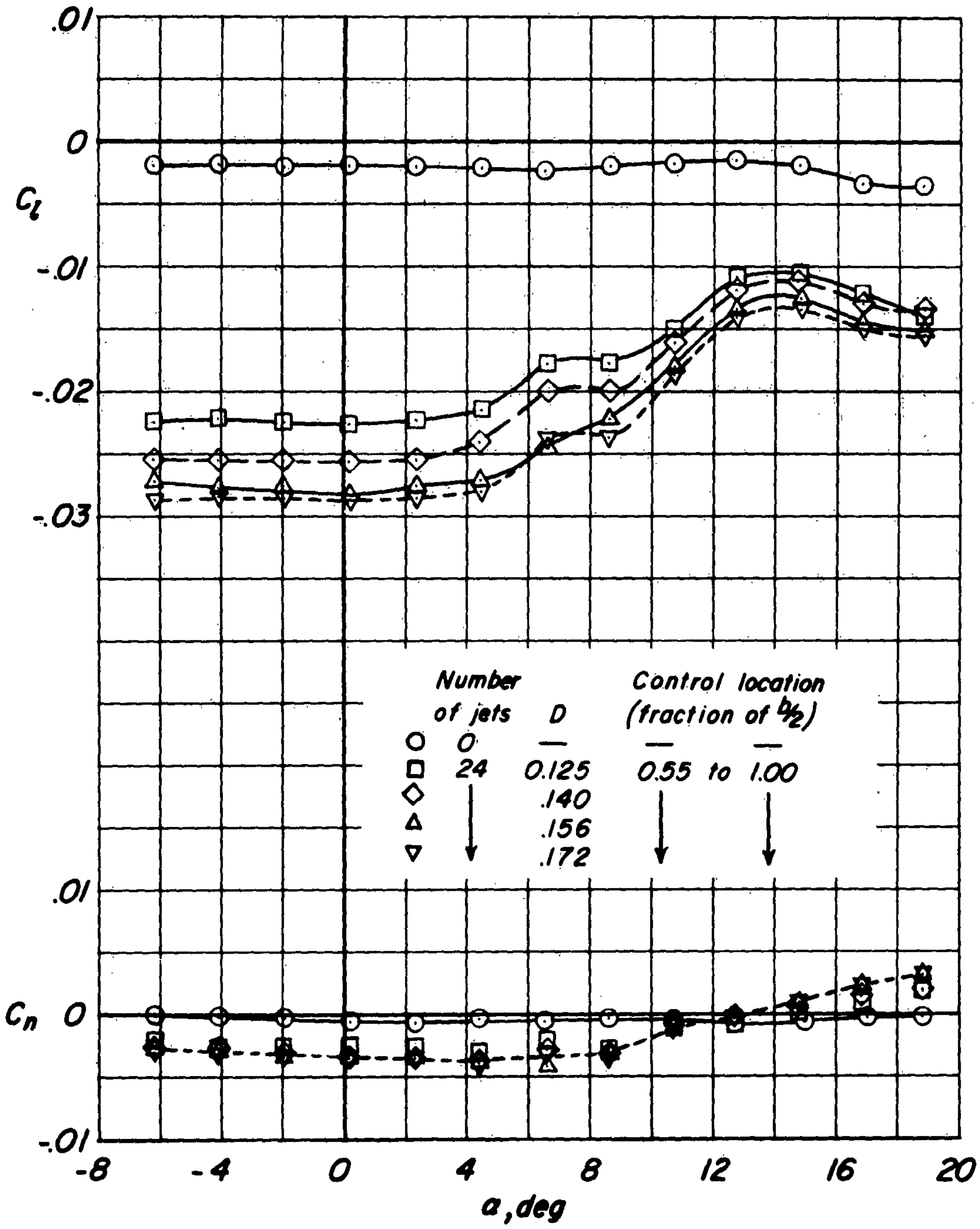

(d) M = 0.90.

Figure 7.- Continued.



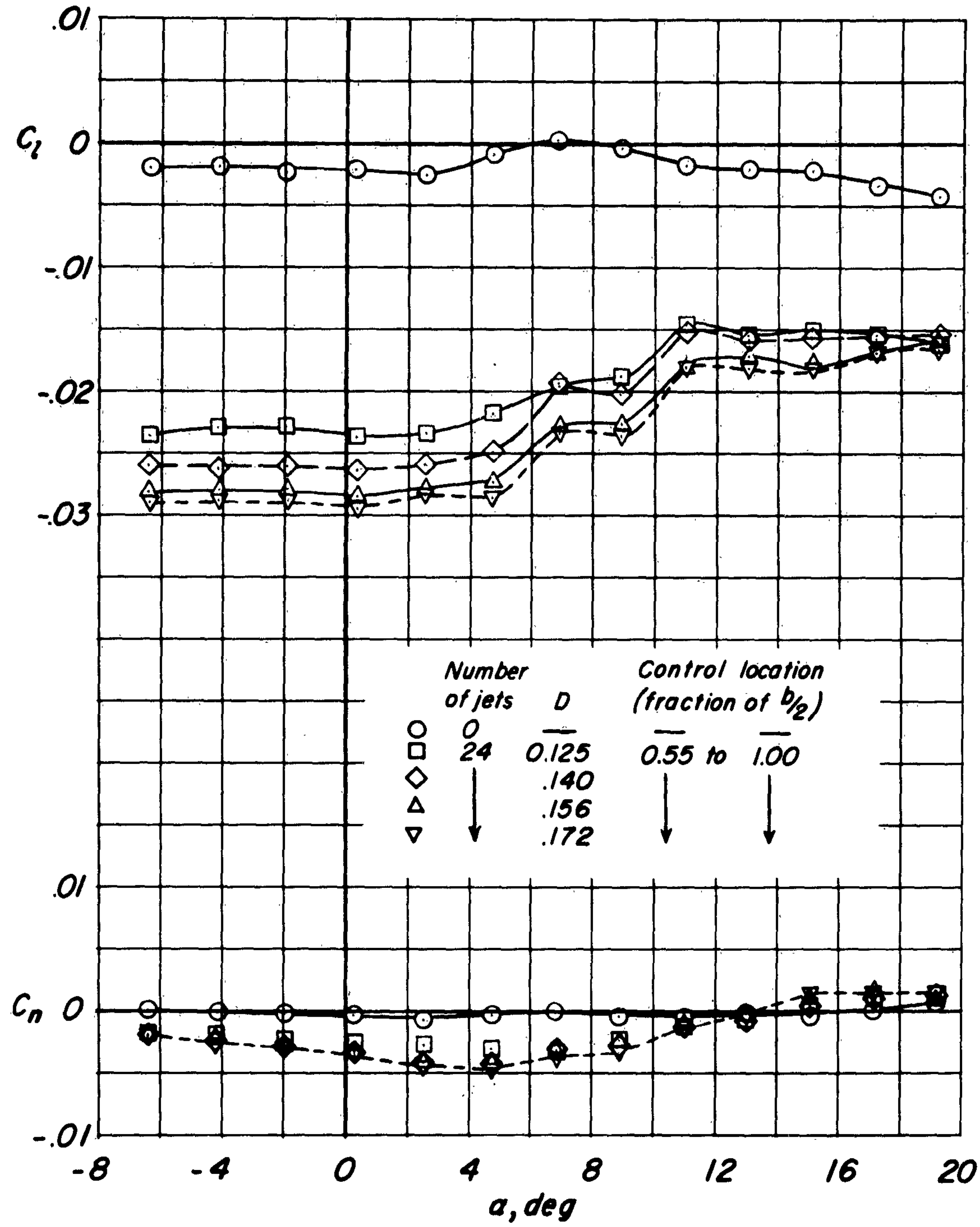

(e) M = 0.96.

Figure 7.- Concluded.



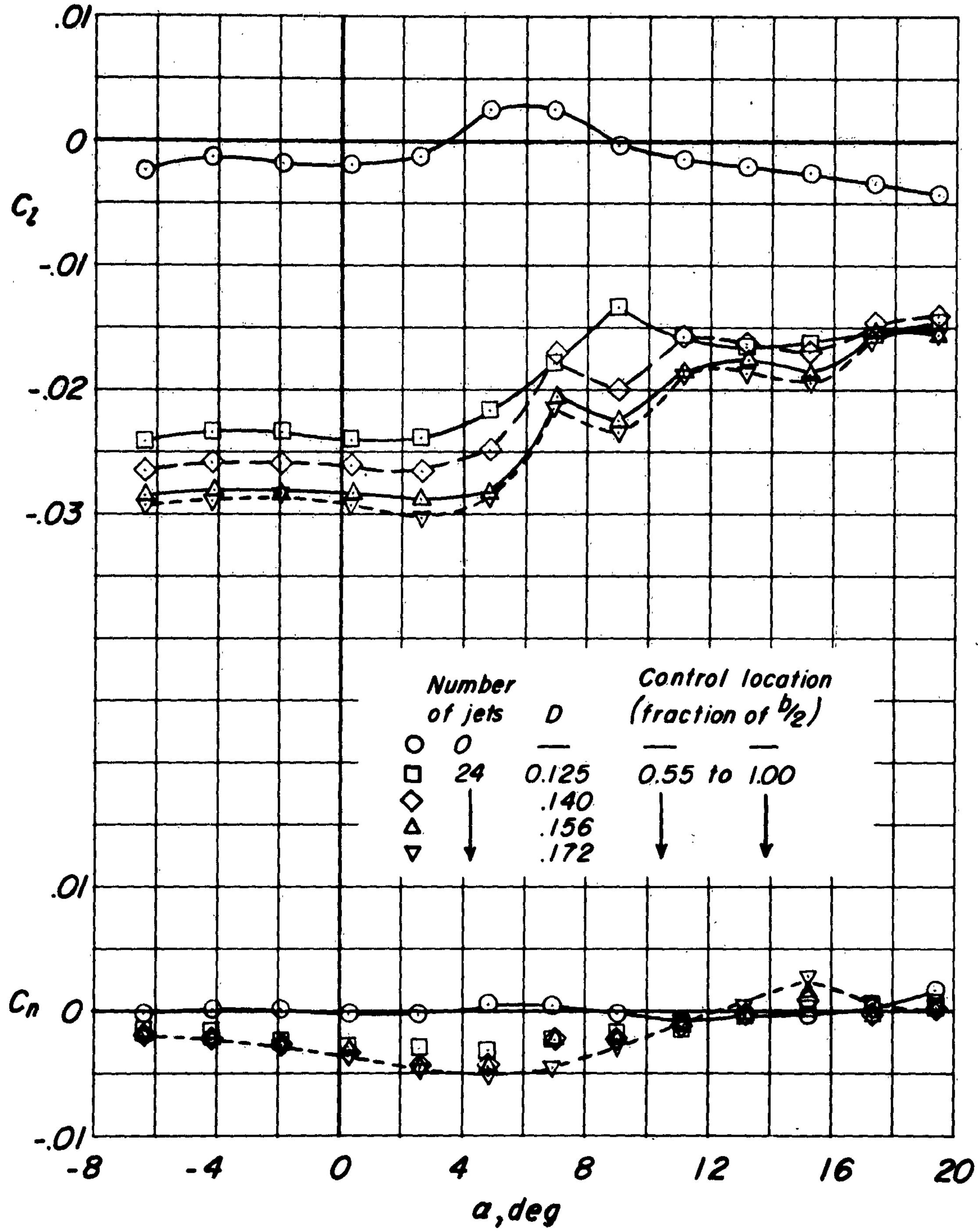

(a) M = 0.60.

Figure 8.- Variation of rolling- and yawing-moment coefficients with angle of attack for control-jet holes of four diameters in the large plenum chamber.



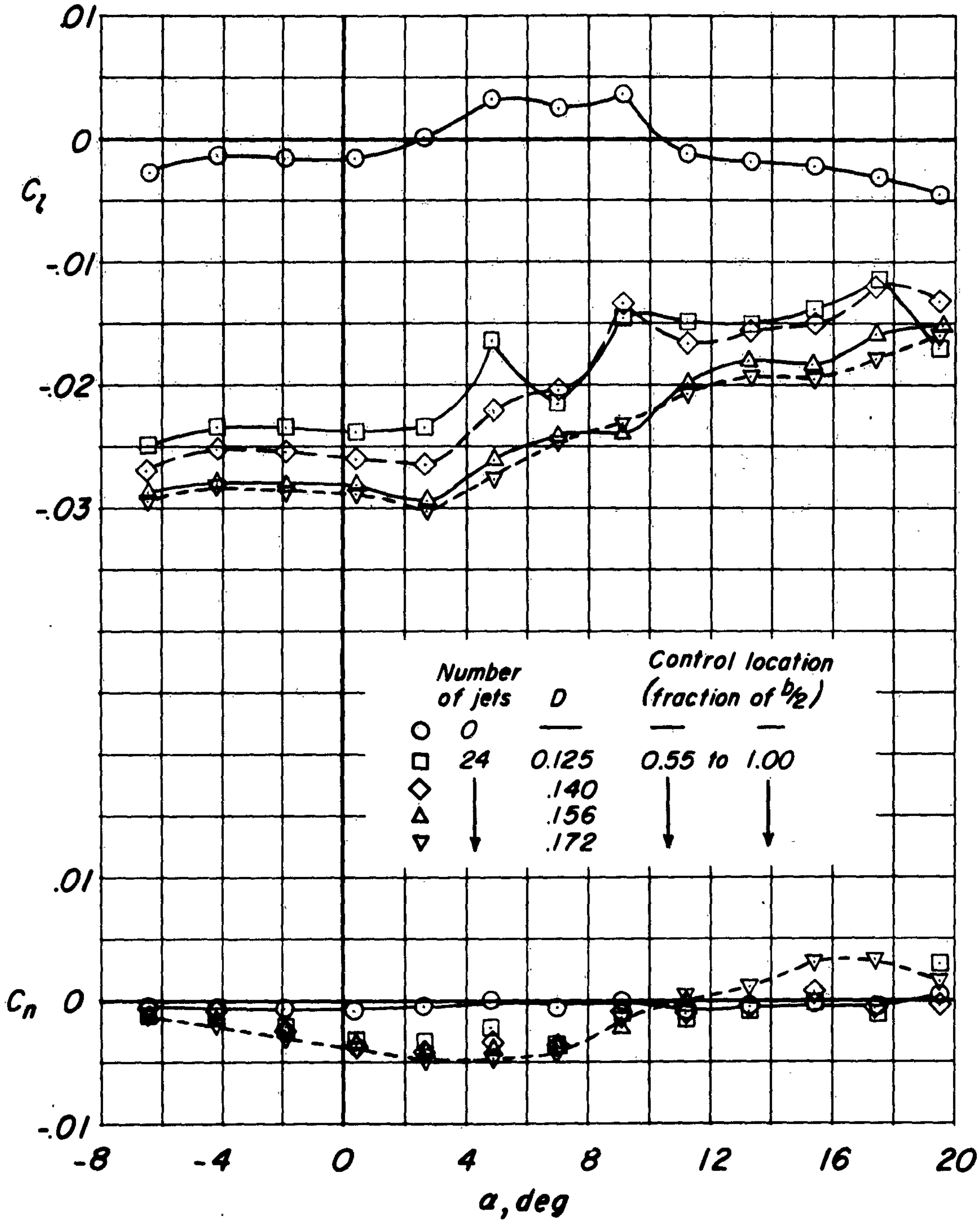

(b) M = 0.80.

Figure 8.- Continued.



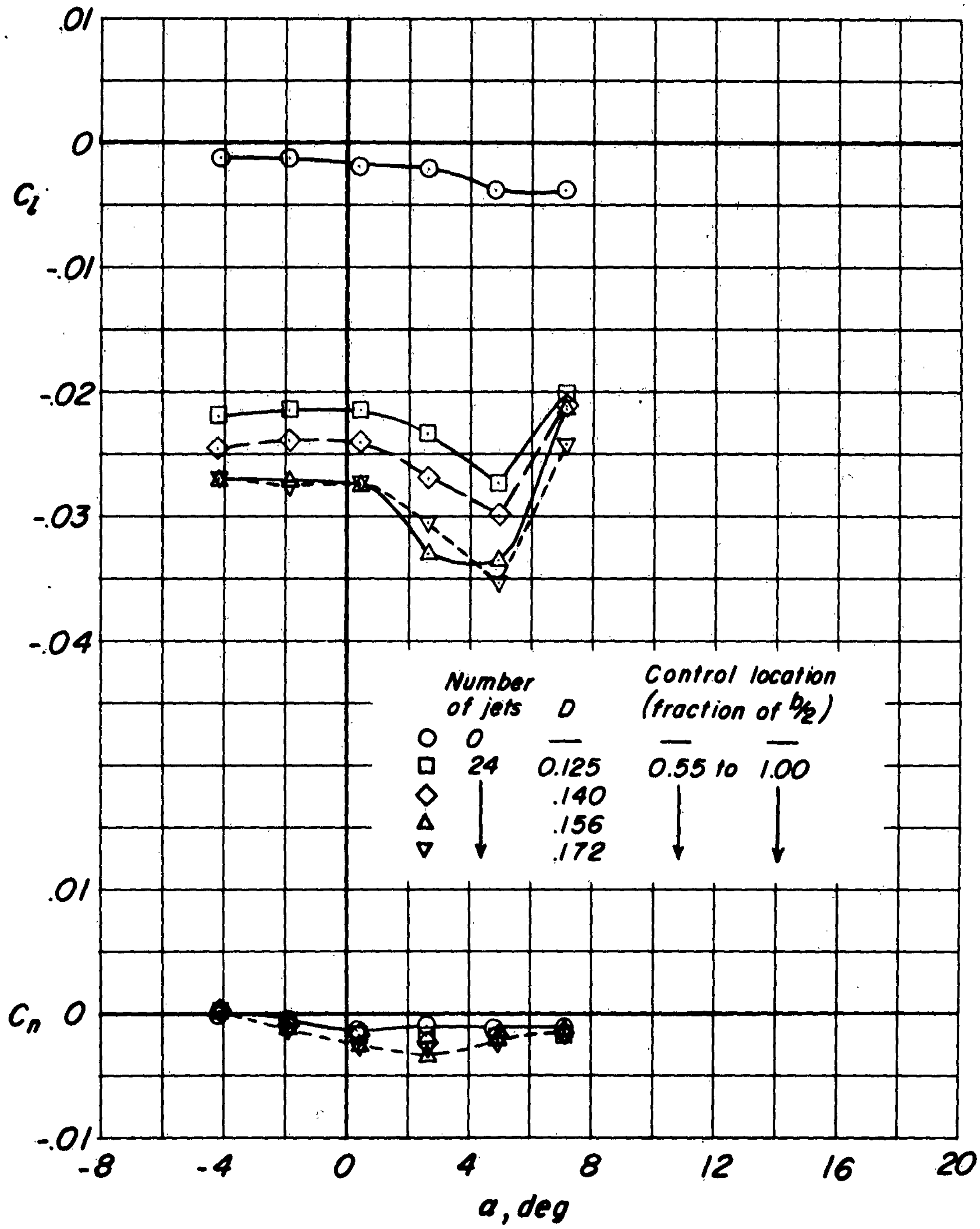

(c) M = 0.85.

Figure 8.- Continued.



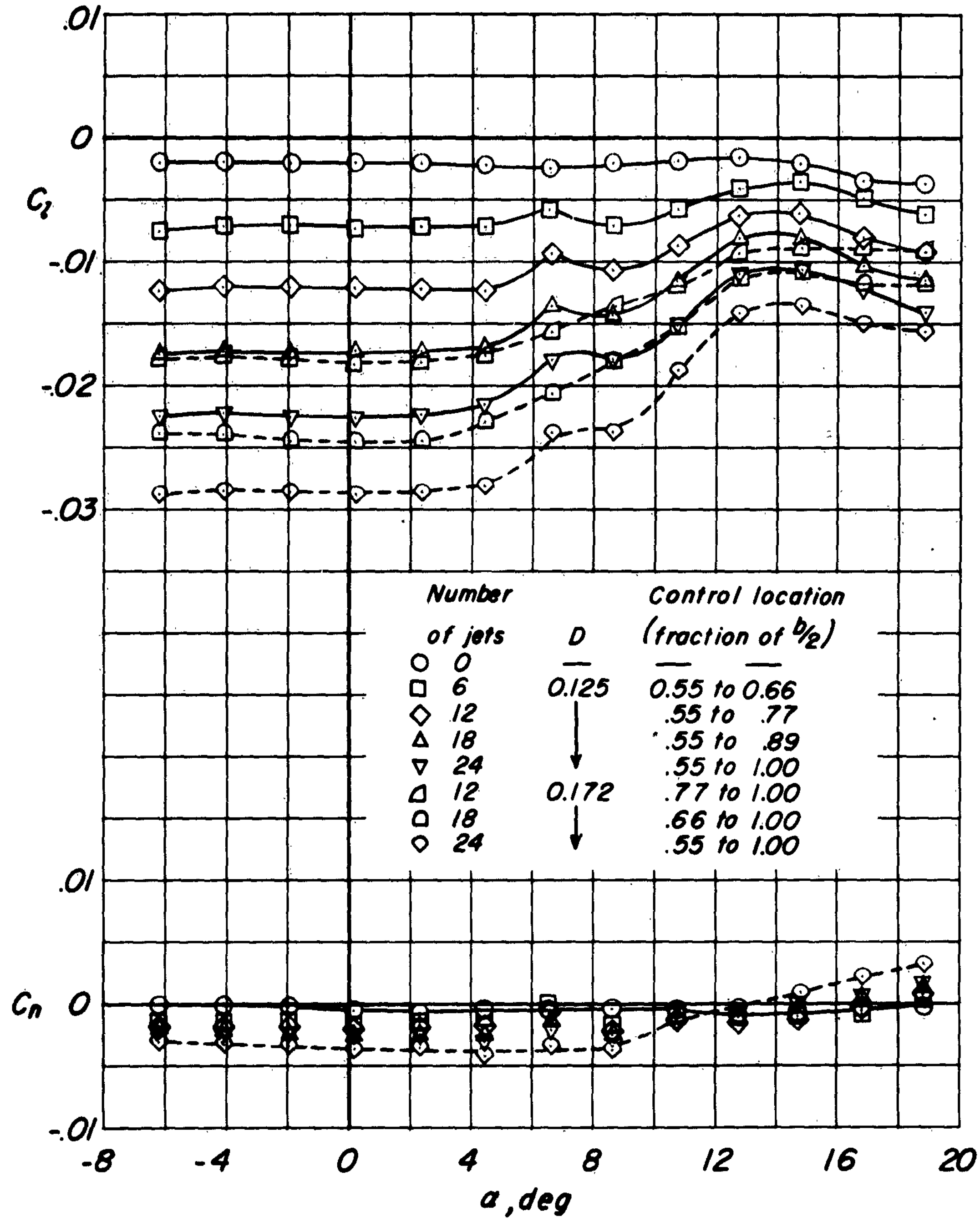

(d) M = 0.90.

Figure 8.- Continued.



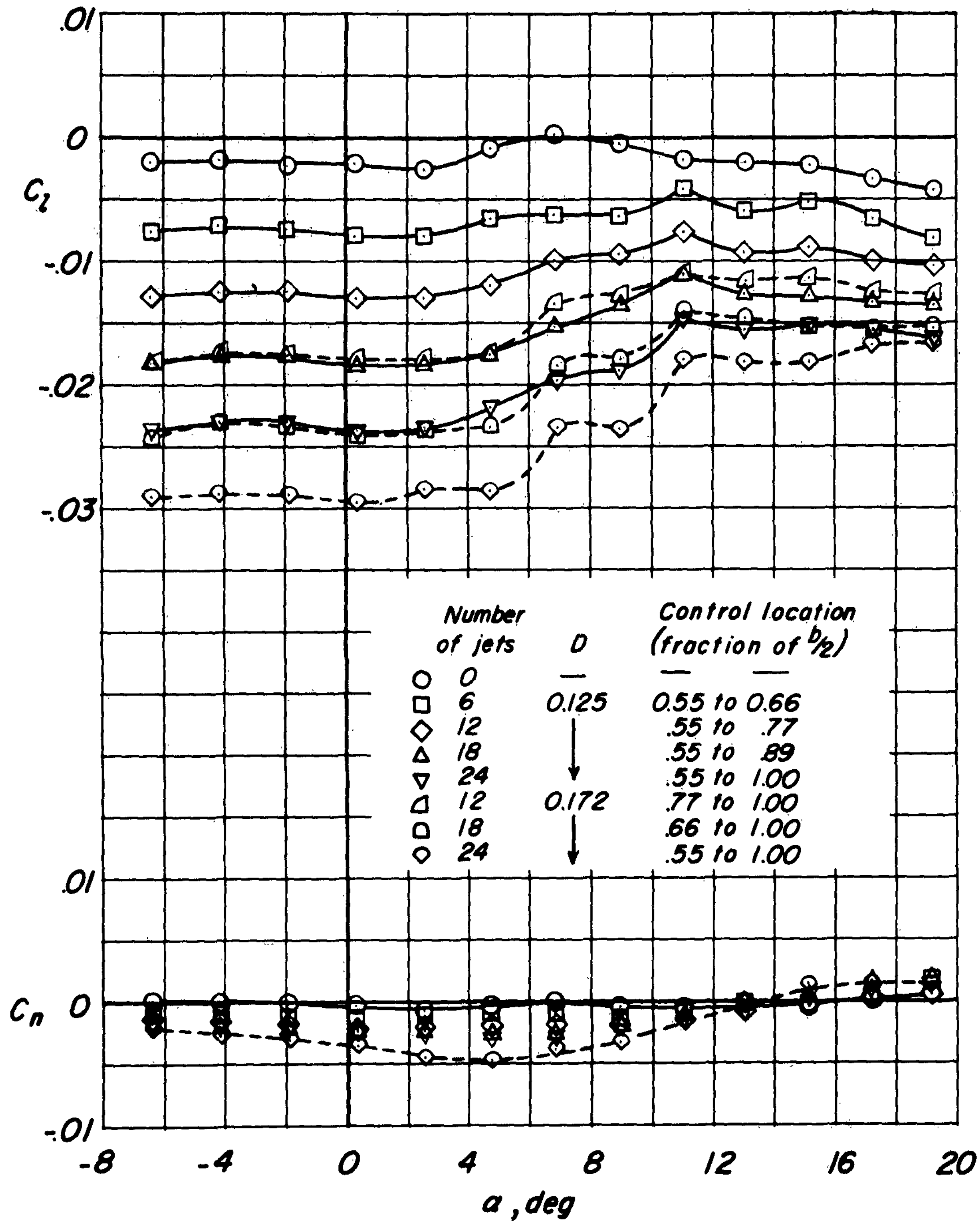

(e) M = 0.96.

Figure 8.- Concluded.



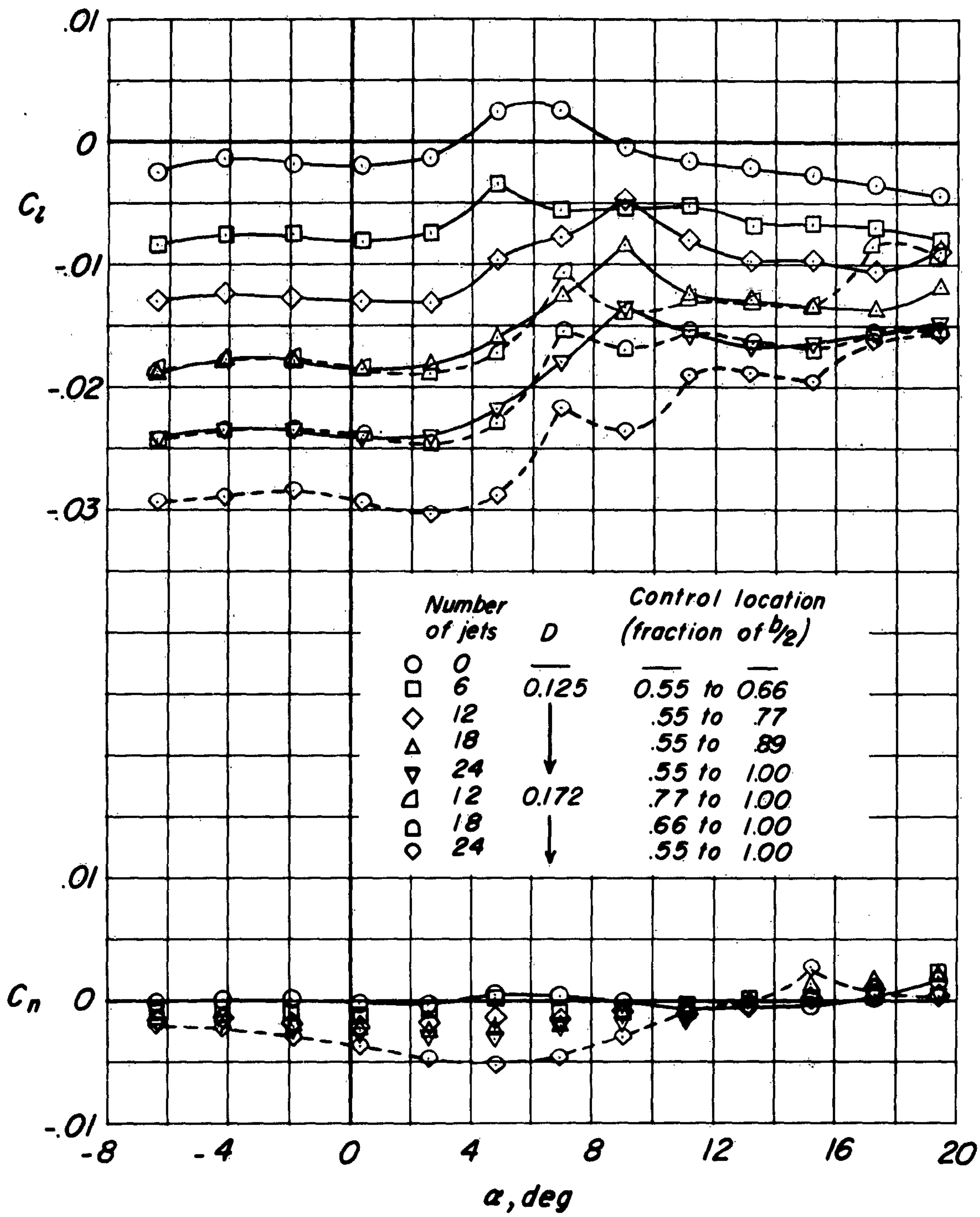

(a) M = 0.60.

Figure 9.- Variation of rolling- and yawing-moment coefficients with angle of attack for wing with partial-span jet controls located inboard and outboard. Large plenum chamber.



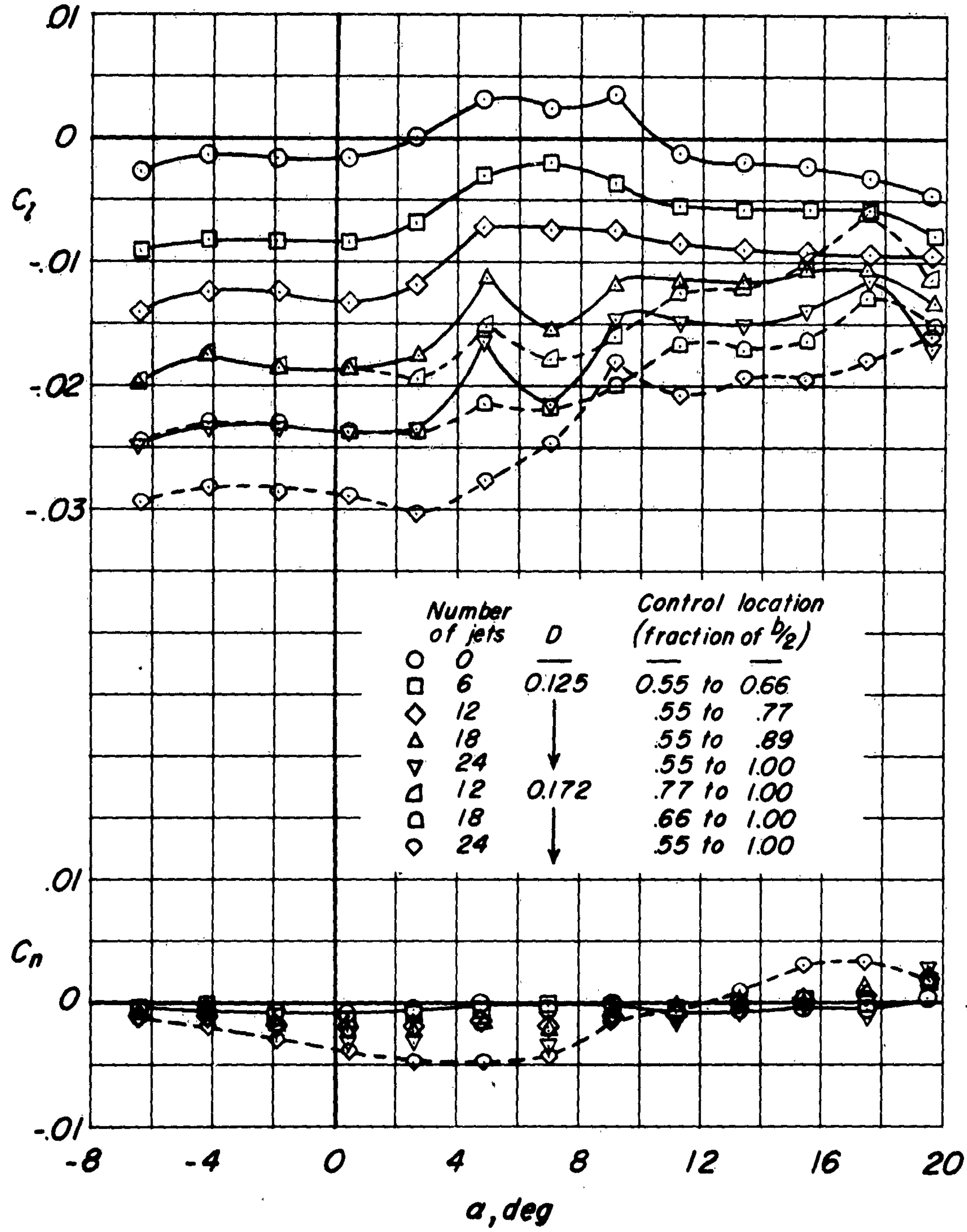

(b) M = 0.80.

Figure 9.- Continued.



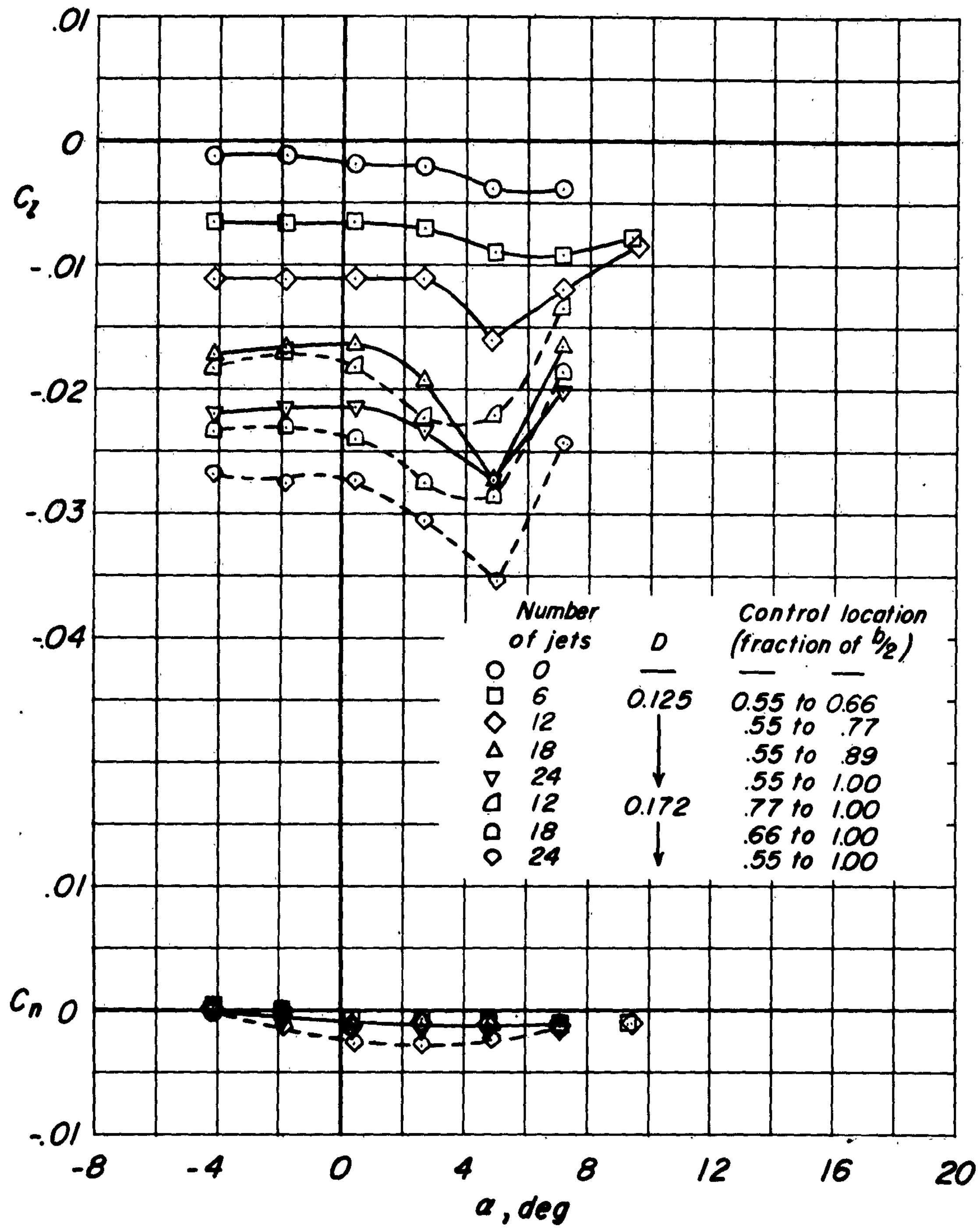

(c) M = 0.85.

Figure 9.- Continued.



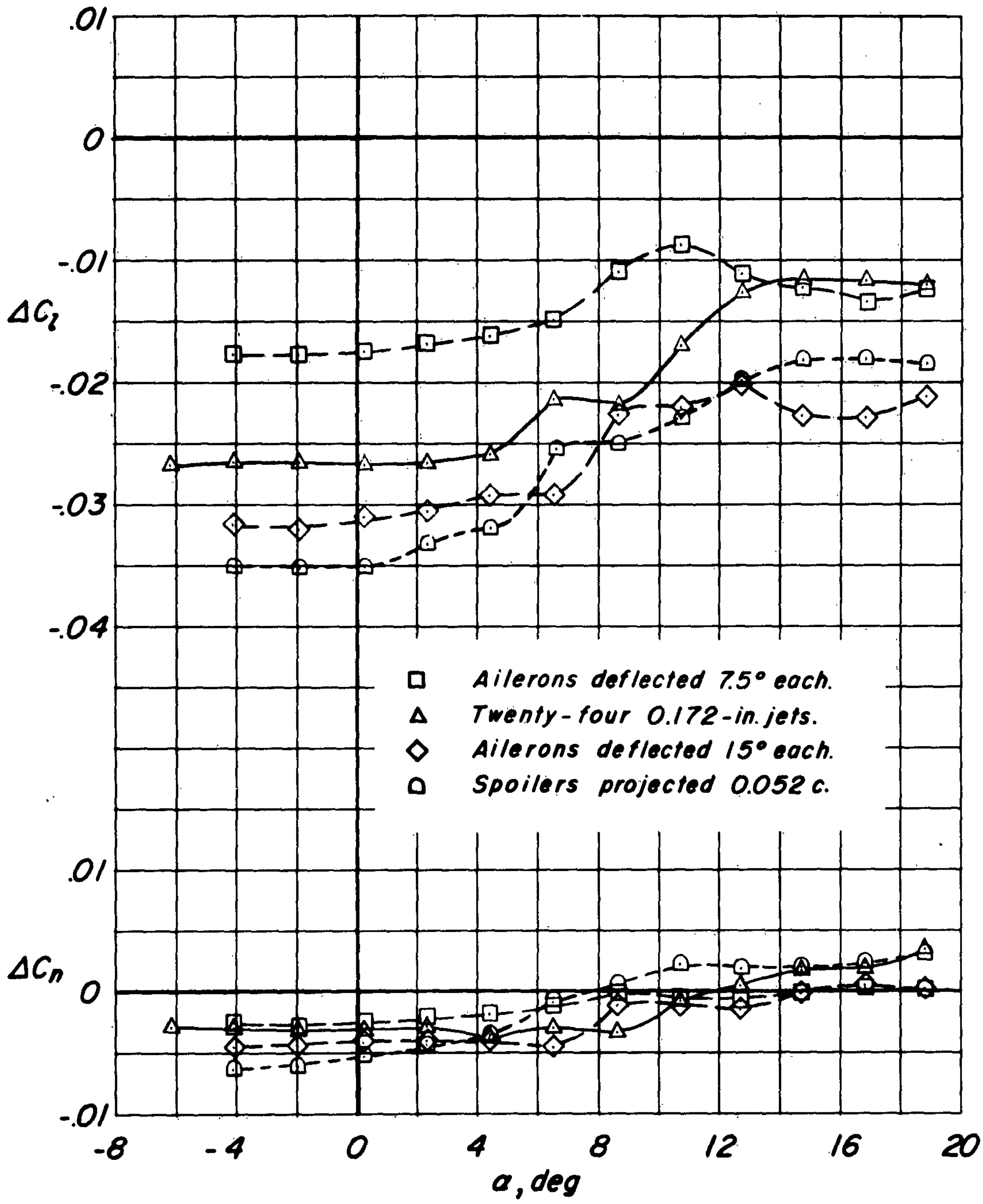

(d) M = 0.90.

Figure 9.- Continued.



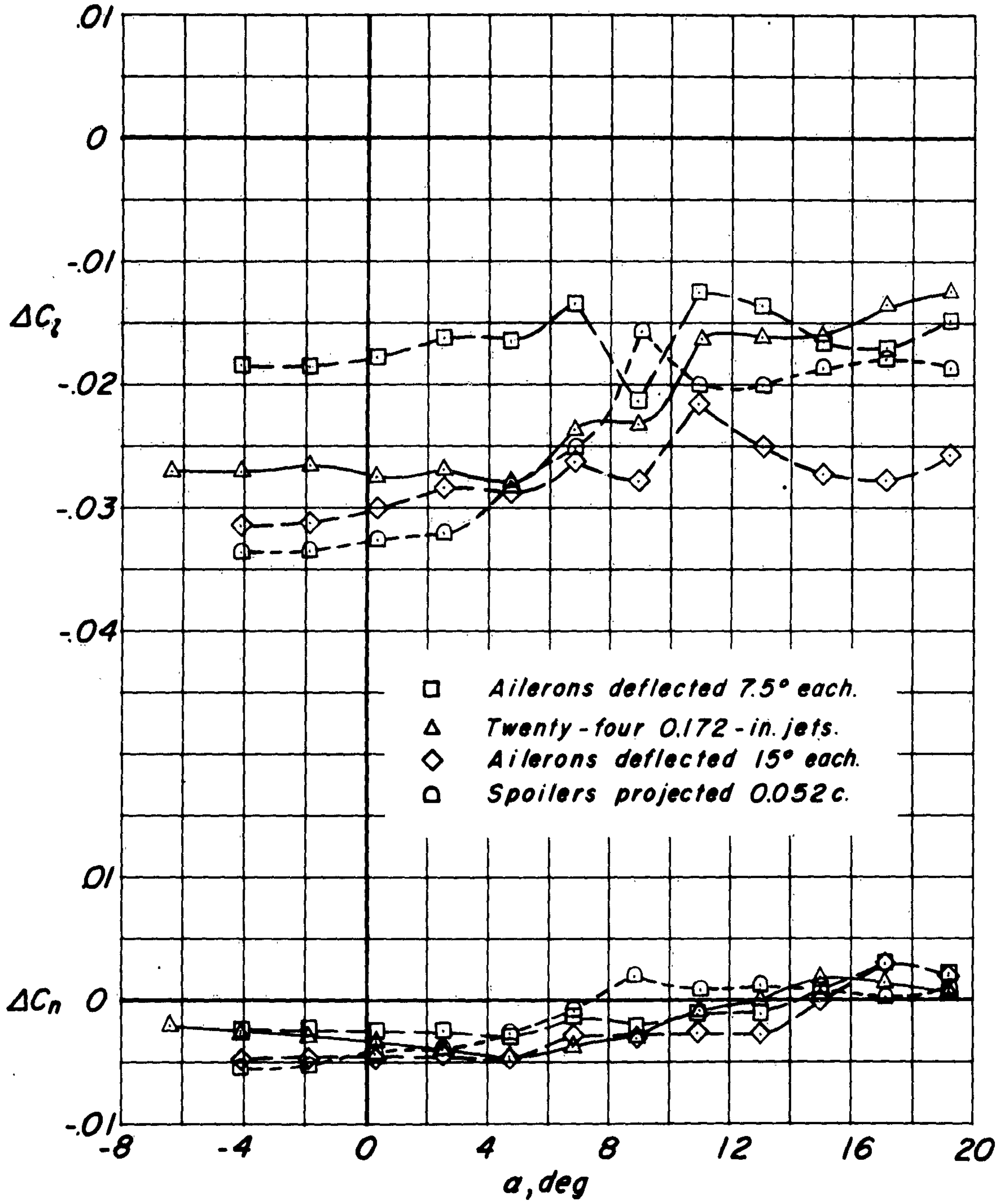

(e) M = 0.96.

Figure 9.- Concluded.



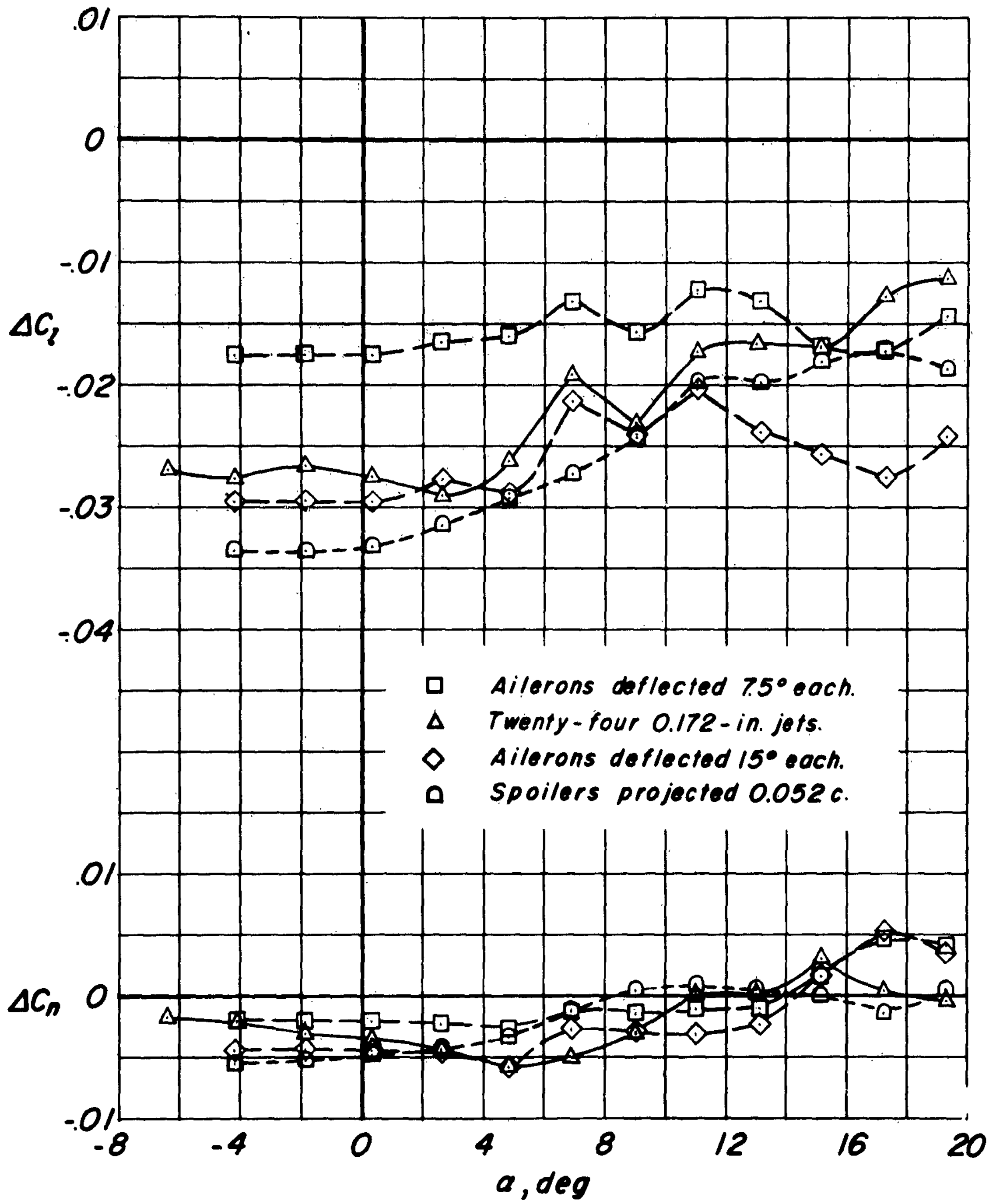

(a) M = 0.60.

Figure 10.- Comparison of rolling- and yawing-moment coefficients produced by jet, spoiler, and aileron controls.



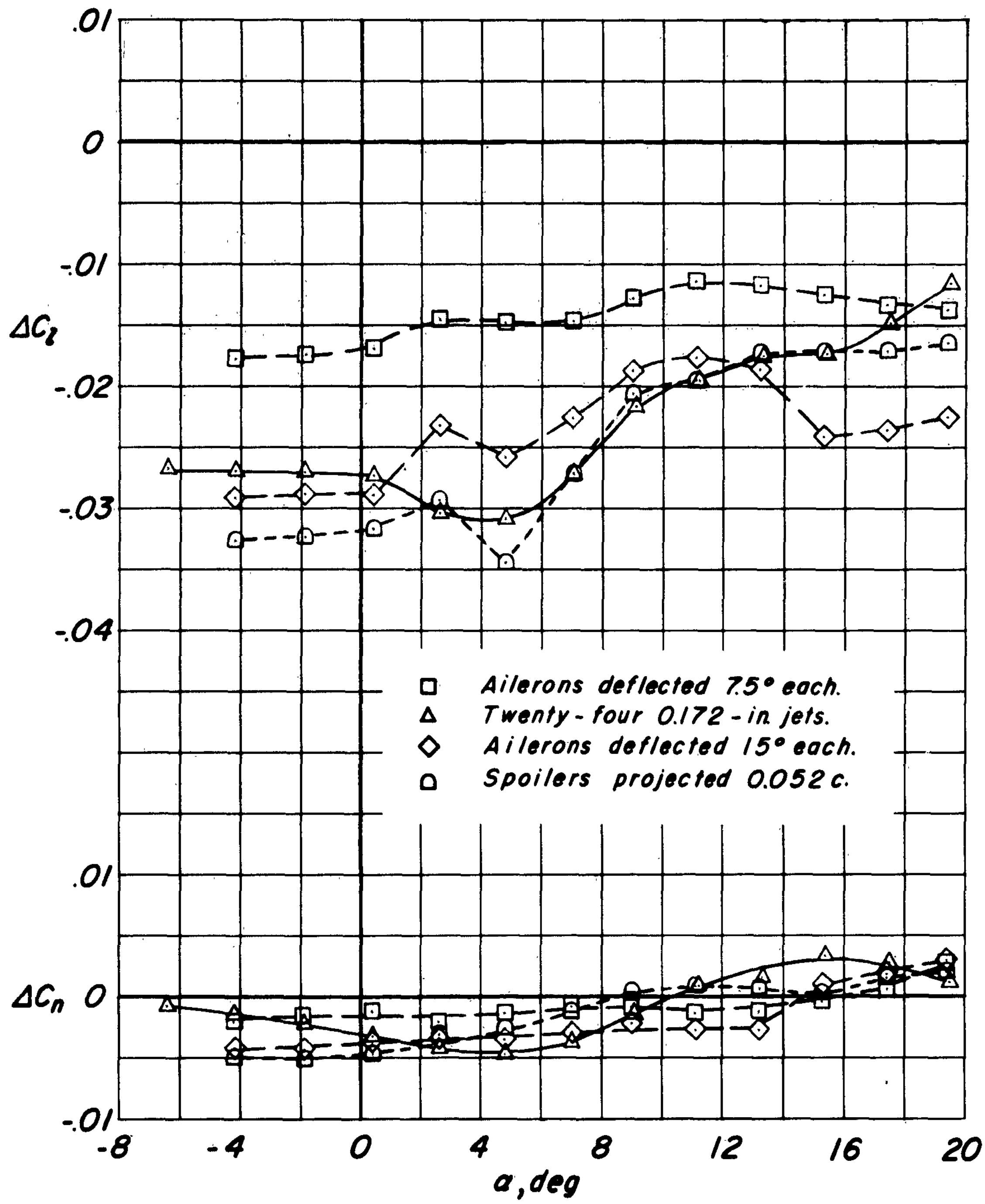

(b) $M = 0.80$.

Figure 10.- Continued.



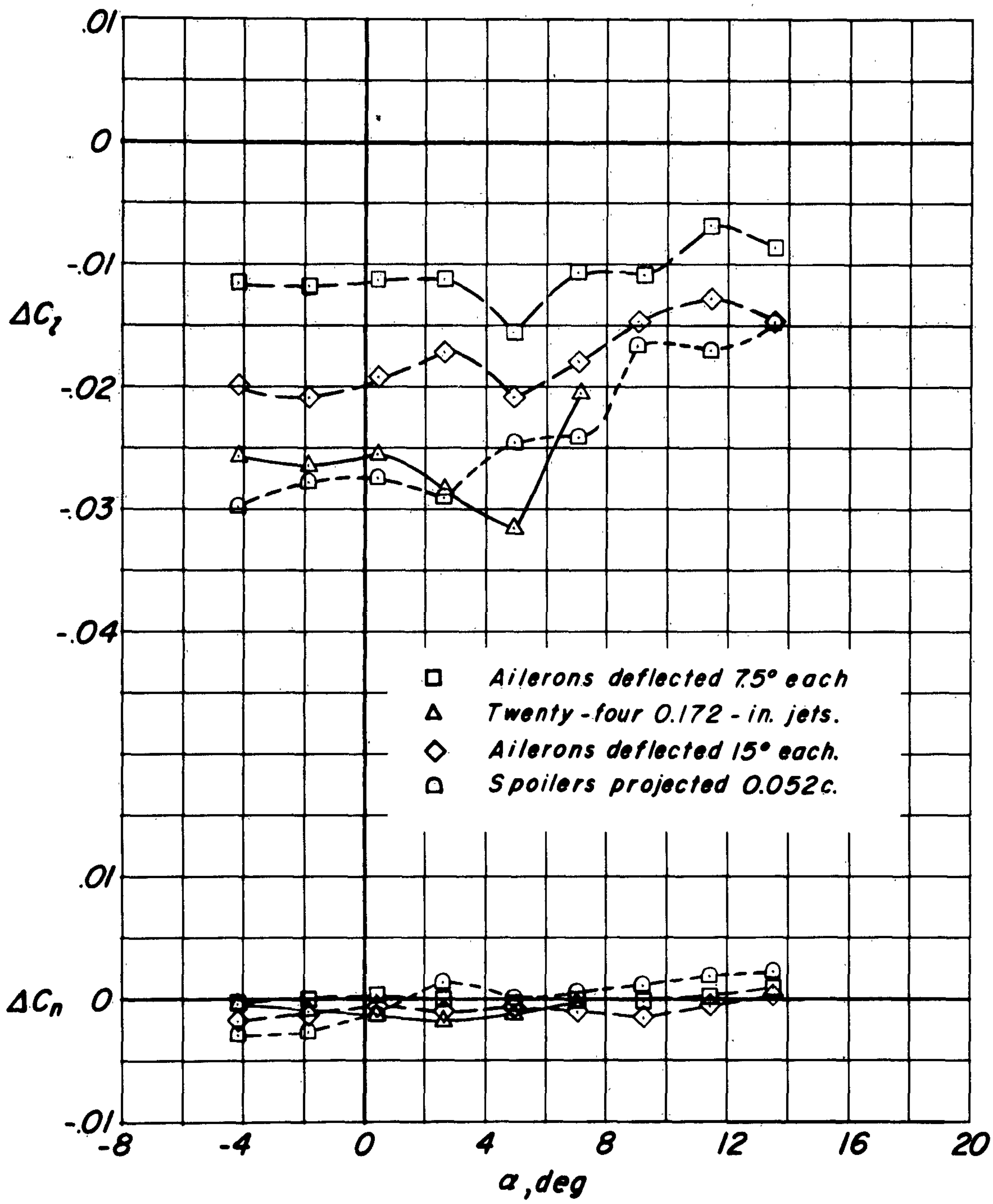

(c) M = 0.85.

Figure 10.- Continued.




(d) M = 0.90.

Figure 10.- Continued.




(e) M = 0.96.

Figure 10.- Concluded.

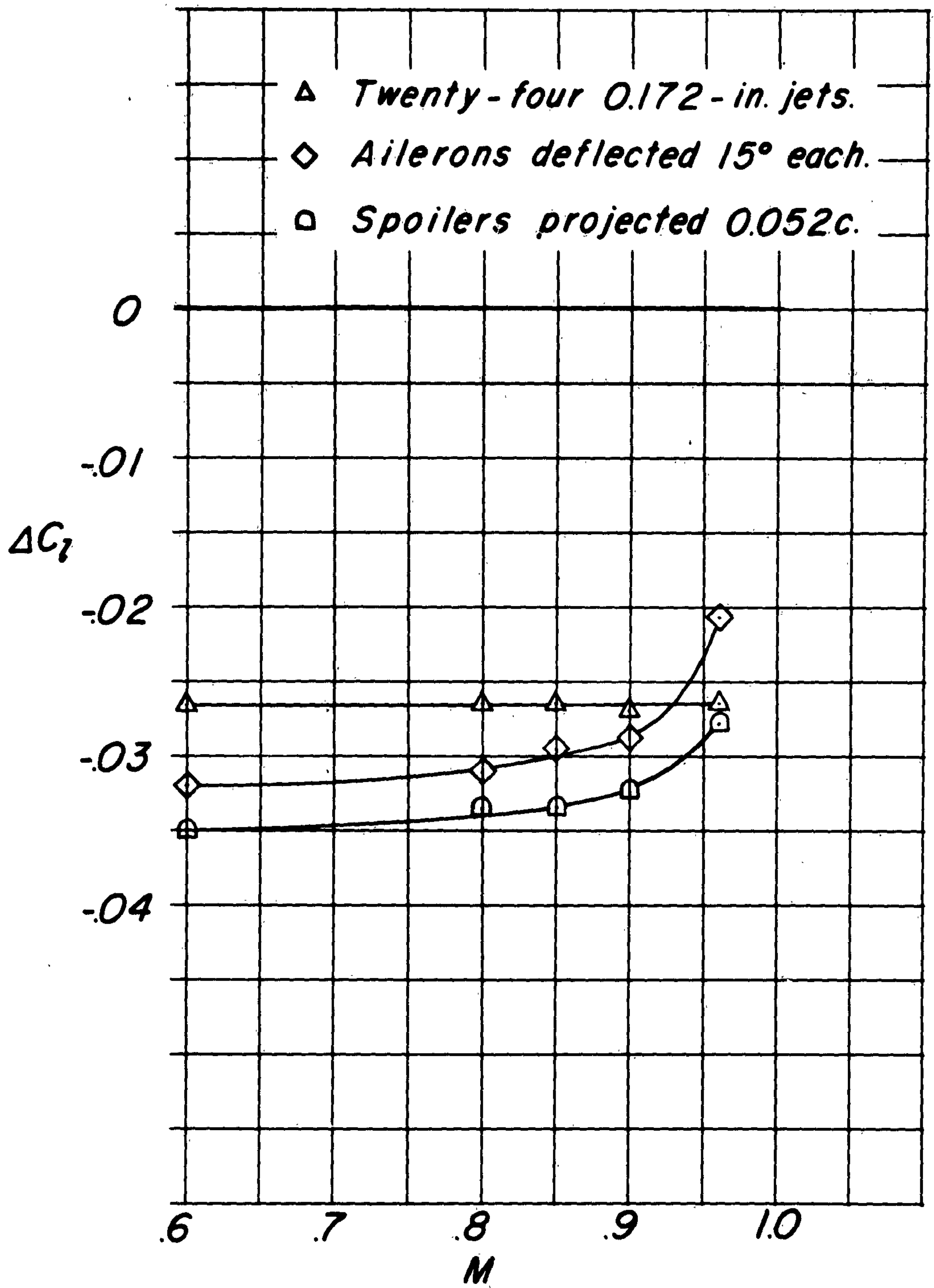
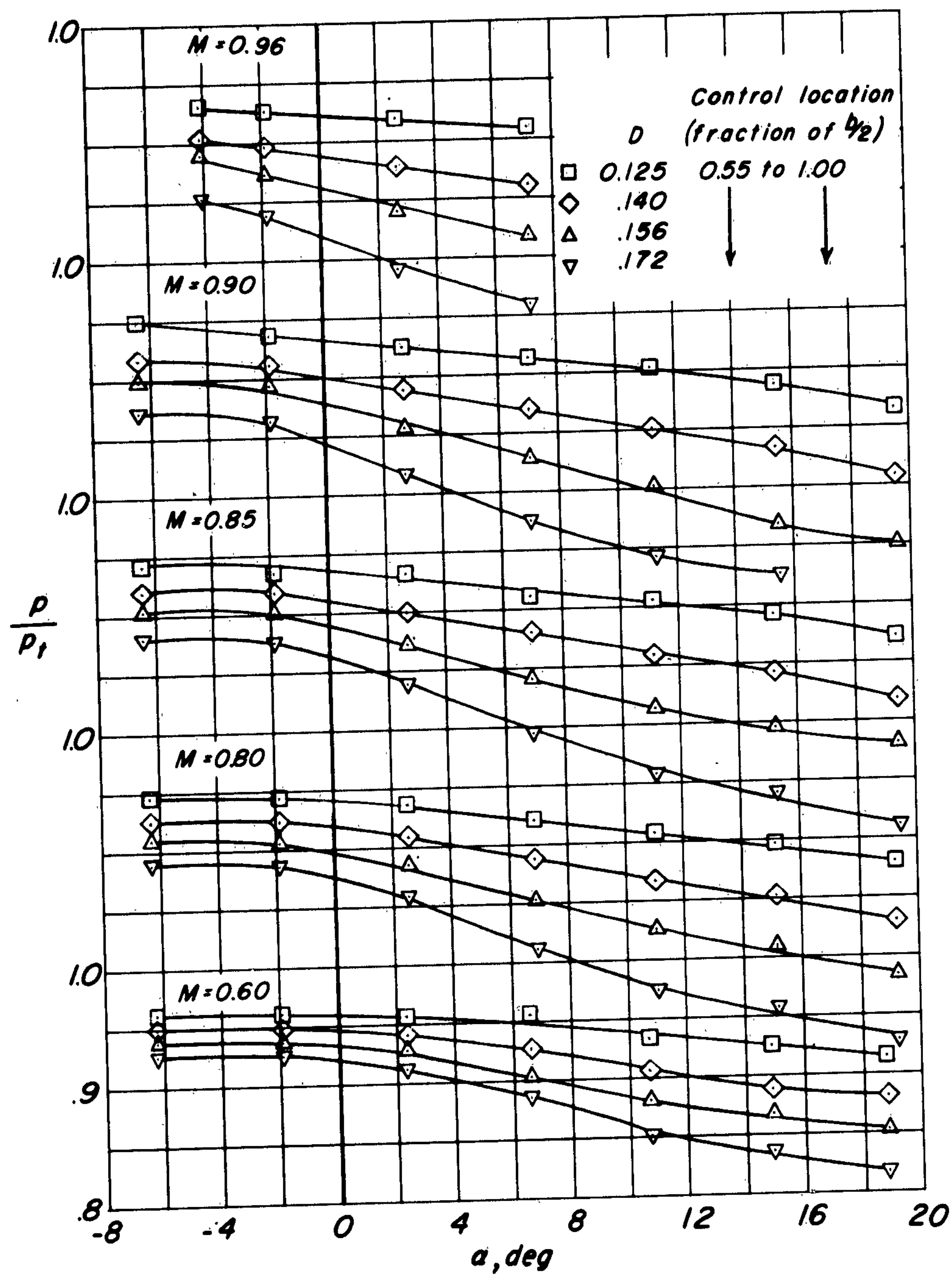
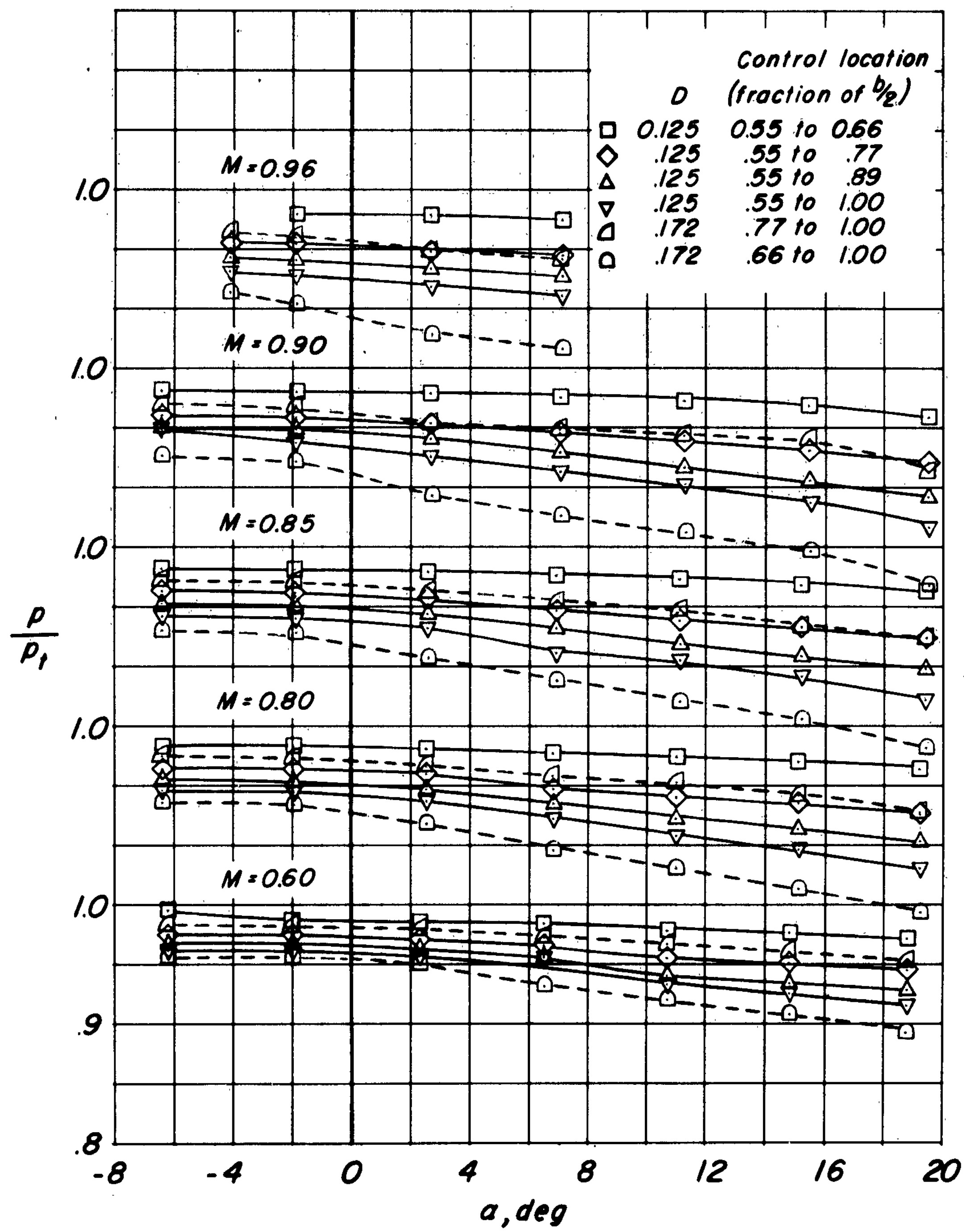



Figure 11.- Variation with Mach number of rolling-moment coefficients produced by jet, spoiler, and aileron controls. $\alpha = -2^{\circ}$.




(a) Constant span controls.

Figure 12.- Ratios of pressure in large jet-control plenum chamber to tunnel stagnation pressure for various angles of attack and jet diameters.




(b) Variable-span controls.

Figure 12.- Concluded.

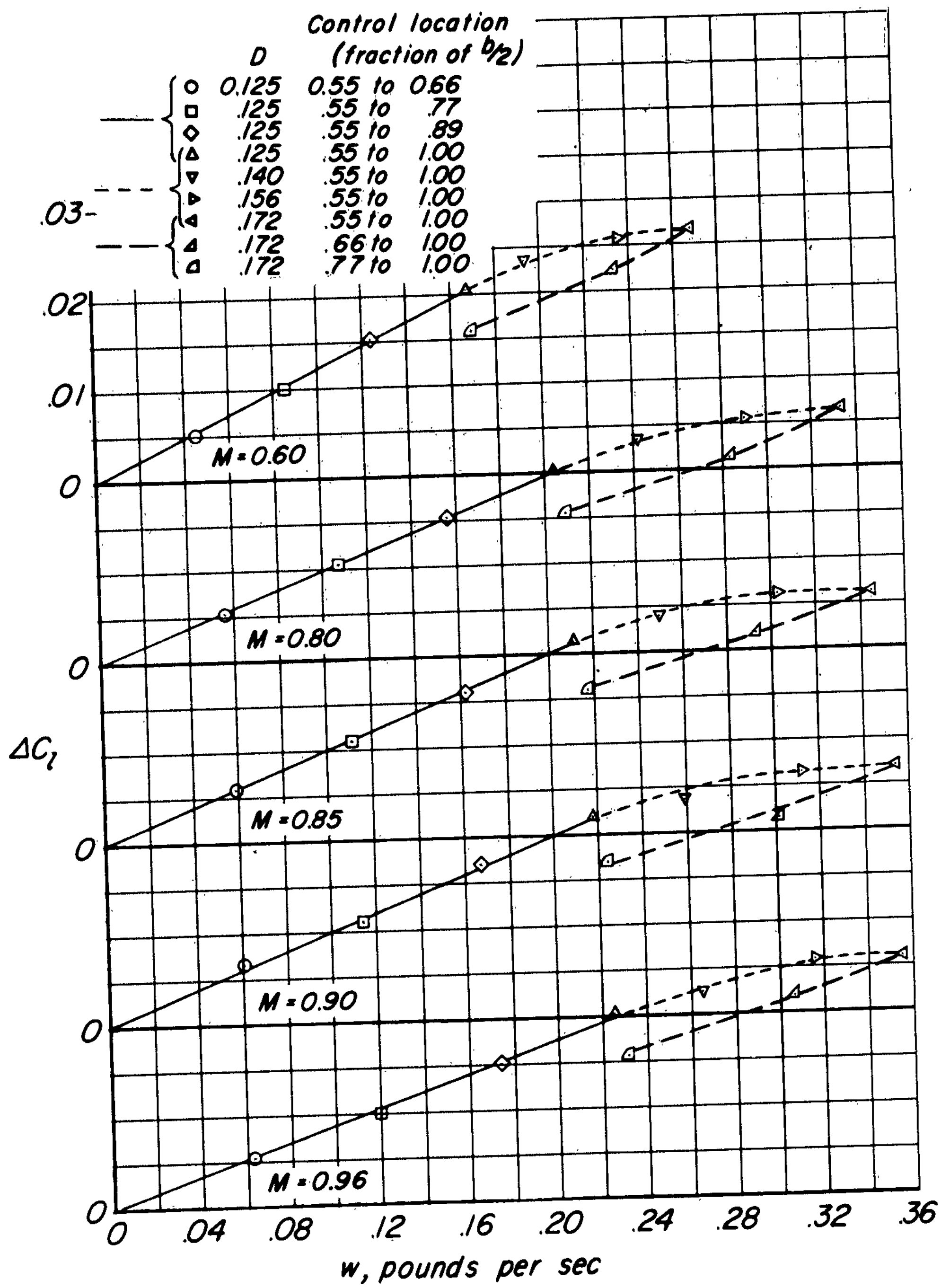



Figure 13.- Variation of rolling-moment coefficient with relative weight flow of air for various jet-control diameters, spans, and locations of controls. Large plenum chamber (w is based on a flow coefficient of unity; correct value is less but unknown). $\alpha = -2^{\circ}$.

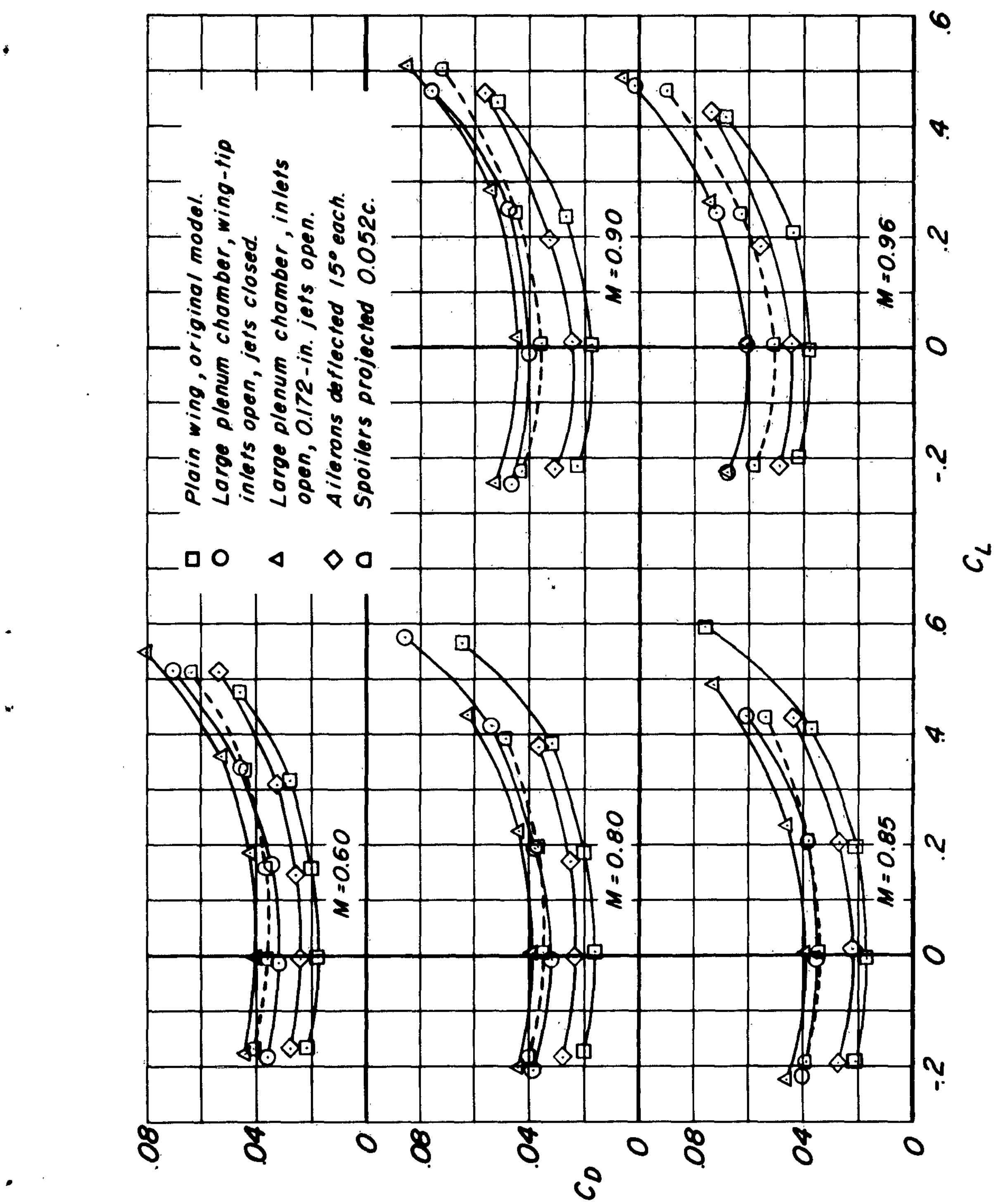



Figure 14.- Comparison of drag coefficients of jet, spoiler, and aileron controls with the plain wing.

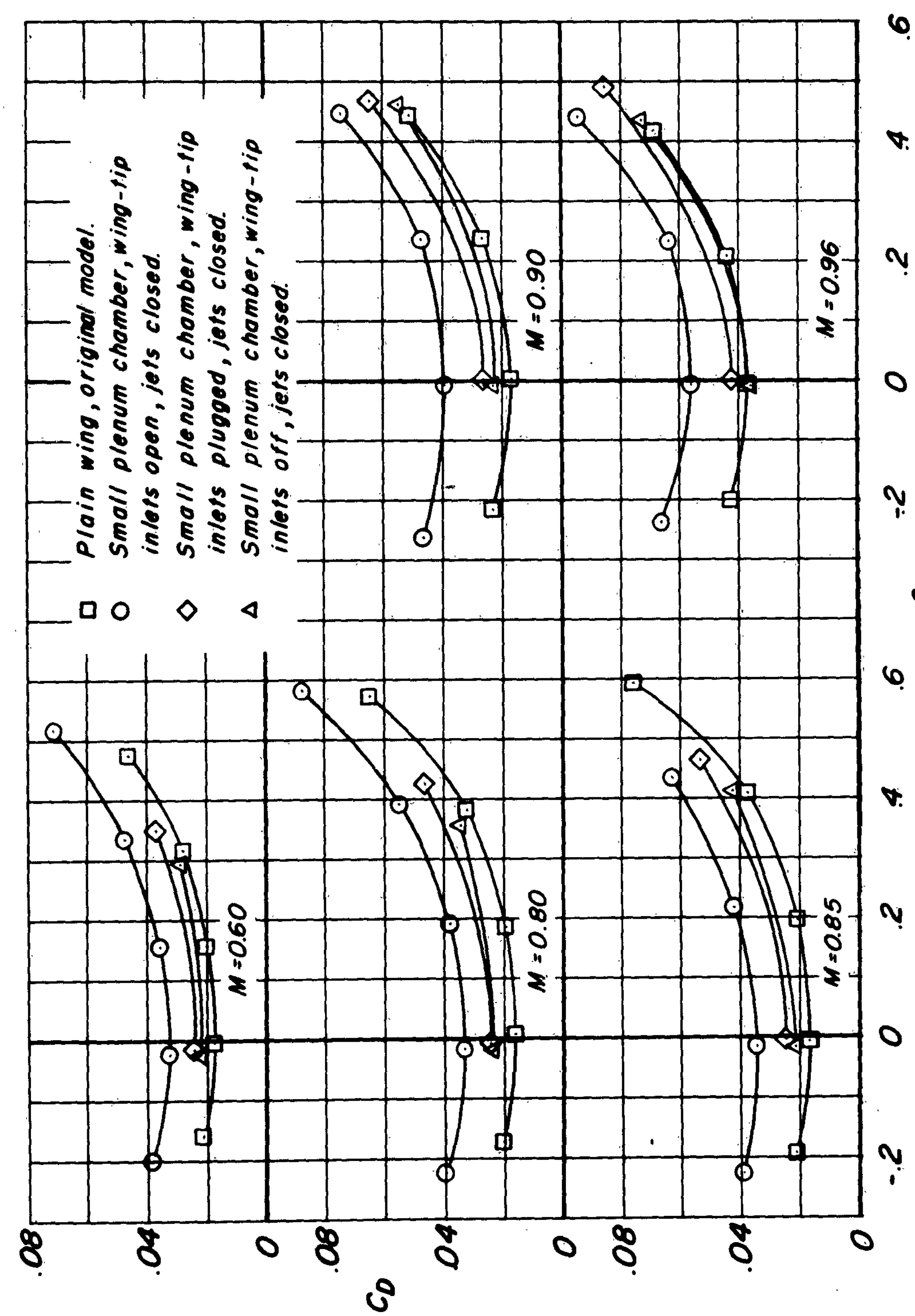



Figure 15.- Effect on the drag coefficients of some modifications to the jet control configuration.



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